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ABSTRACT

The purpose of this study was to evaluate the effects of using different mathematics textbooks on the mathematical computational ability of students as a method of assessing the effectiveness of different mathematics instruction. This study resulted from a 1963 report which discussed the results of the Mew Hampshire Statewide Eighth Grade Testing Program and the observation that a significant drop in the arithmetic computation scores occurred in 1964 and 1965. A study of the data collected in 1967 involved three different phases. The results of phase one indicated that the introduction of modern mathematics is somewhat responsible for the decline in computational ability. The second phase compared the arithmetic computational ability of 1965 eighth graders with 1967 tenth graders. The results suggested no significant differences in computational ability in grade ten between traditional, transitional, and modern groups. The third phase involved a select group of tenth graders and their abilities in algebra and geometry. The conclusions were that students who had studied either a modern or a transitional textbook did markedly superior work to those who had used only a traditional textbook. (FL)



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A LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES OF NEW HAMPSHIRE'S EIGHTH GRADERS: 1963-1967

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August 15, 1969

U.S. Department of Health, Education and Welfare

Office of Education

Bureau of Research

SUMMARY

A LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES OF NEW HAMPSHIRE'S EIGHTH GRADERS 1963-67

The intent of this study was to assess the impact of the introduction of modern mathematics text books on the computational ability of students in New Hampshire. In 1963 a report discussing the results of the New Hampshire Statewide Eighth Grade Testing Program, written by Dr. Walter N. Durost, indicated the mean raw score in the state of New Hampshire in arithmetic computation was 34 raw score points, and its grade equivalent was 8.8. This was consistent with a pattern that had been established for some years. New Hampshire had always done well in the area of arithmetic computation.

1.4

In 1964 the pattern changed markedly. It became apparent that there had been a significant drop in the arithmetic computation scores since 1963. This drop continued into 1965 when the first study authorized by the New Hampshire State Department of Education was conducted by the Bureau of Educational Research and Testing Services. The results of that study clearly indicated, for the three groups designated as modern, traditional, and transitional, that in intellectual skills as measured by the Otis Intelligence Test, the modern group was clearly superior, followed in order by the group classified as being transitional, and the group classified as being traditional. On mathematics computation the exact inverse was true. The traditional group scored highest, followed by the transitional group, followed by the modern group.

The first phase of this study of the 1967 data was a replication of that earlier 1965 study. The results clearly indicate that again the group classified as modern was intellectually superior to the groups classified as traditional or transitional, as measured by the School and College Ability Test. The computation sub-test of the Stanford indicated the modern group performs no better than the transitional group. It needs to be pointed out, however, that the scores obtained by each of these groups on the Stanford Arithmetic Computation sub-test were markedly lower than they were in 1965 and still lower than they were in 1963. In 1963, using the Metropolitan in a fall administration, the grade equivalent was 8.8. In 1967, using the Stanford in a fall administration, the grade equivalent was 6.8. This means that in five years, 1963-1967, there had been a two-year decline in mathematics computation abilities in New Hampshire. It is not possible to conclude from this study that this is a direct result of the kind of text books used, but it is the author's opinion that the introduction of modern mathematics is at least somewhat responsible for the decline in computational ability.



It is believed by the author that even in traditional and transitional schools, so designated by their text books, there has been increasing emphasis on understanding with a corresponding decrease in the time allocated to practice of meaningful drills in arithmetic computation.

A second phase of this study was to compare the performance of community (1965) eighth grade means with community (1967) tenth grade means to make comparisons of arithmetic computational ability between eighth and tenth grade. The findings clearly indicate that although there were differences depending upon the kind of text book used at eighth grade, this is no longer true at tenth grade. There are no significant differences in mathematical computational ability at grade ten between these three groups as measured by the Stanford Numerical Competency sub-test. There are, however, interesting and provocative differences using the Stanford High School Mathematics sub-test, Part A, which measures Algebra and Geometry. We find very real and important differences in students' abilities dependent upon the kind of text book the, have been exposed to.

The third phase of this particular study was to take a select subgroup of tenth graders and compare their abilities in the area of
Algebra and Geometry, still controlling for the type of text book
that they had used in their previous years of school. We find
clearly that students who have studied in either a modern or a transitional text book do markedly superior work to those who have studied
using only a traditional text book.

Results of these three studies in mathematics computational abilities in the state of New Hampshire would seem to indicate the following: There has been a serious decline in mathematics computational ability at grade eight in the state of New Hampshire. By grade ten this difference is no longer statistically significant. It also becomes apparent that modern mathematics begins to pay its greatest dividends when students are being expected and requested to master the concepts associated with Algebra and Geometry. This, it seems to the author, provides information on which Superintendents, Principals, and curriculum workers in the area of mathematics might make important curriculum decisions. The implications of these studies argue cogently, the author believes, for the use of differentiated text books in school systems.



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A Longitudinal Evaluation of Mathematical Computational Abilities of New Hampshire's Eighth Graders: 1963-1967

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August 15, 1969

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A LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES OF NEW HAMPSHIRE'S EIGHTH GRADERS (1963) AND EIGHTH GRADERS (1967)



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In the fall of 1963, under the direction of Dr. Walter N. Durost, the Test Service and Advisement Center conducted the sixth consecutive yearly statewide testing program at grade eight for the New Hampshire State Department of Education. The program consisted of a mental abilities test, the Otis Quick-Scoring Test, Gamma, Form Fm and the Metropolitan Advanced Battery, Form Bm.

The research reported in this paper was conducted with the sponsorship of the New Hampshire State Department of Education and a grant from the United States Office of Education, grant number OEG-1-9-090023-0106 (010). The purpose of the research was to evaluate empirically the effects of using different mathematics text books on the mathematical computational ability of students as a method of assessing the effectiveness of different mathematics instruction, where it is assumed that the choice of text reflects methods of teaching.

In his 1963 report, Dr. Durost indicates that the median raw score for the state of New Hampshire in arithmetic computation was 34 raw score points. The equivalent standard score was 55 and the grade equivalent was 8.8. This was consistent with a pattern that had been established for some years. In 1961, for instance, the median grade equivalent was 8.7 and in 1962 it was 8.7, so I believe it is safe to say that for a period of years New Hampshire, in its 8th grade testing program, which was conducted in November, was rather markedly above the national norm in terms of its achievement in the area of arithmetic computation.

In 1964 the pattern changed markedly. The median raw score for New Hampshire dropped to 31 raw score points, providing a standard score of 52 and a grade equivalent of 8.3. In his 1964 report, Dr. Durost makes the following statement:

"It is suspected that the adoption of the new curriculum in mathematics in New Hampshire may have resulted in the drop in Arithmetic Computation. This influence has been noted in other studies in communities where data are available over a period of years and where the new curriculum has recently been introduced."

In 1965 the 8th grade testing program was conducted by the Bureau of Educational Research and Testing Services at the University of New Hampshire. The state report of that year indicates that the median raw score for the state of New Hampshire in the arithmetic computation subtest of the Metropolitan was 30. This equalled a grade equivalent of 8.1 which indicated a continuing drop in New Hampshire's arithmetic computational ability. As a result of that finding the State Department of Education authorized the Bureau to conduct a study which would attempt to determine whether in fact the introduction of modern mathematics was having a detrimental effect on the computational ability of New Hampshire's 8th graders. The study was conducted in the following manner: in 1965 the total number of students tested in the state was 4,724. Of this number, 4,182 were included in the study. The 8th grade classes which participated in this voluntary statewide program were placed in one of four categories which were designated as follows:



modern, traditional, transitional and other. 542 students were eliminated from the study by being placed in the category called other. Placement in these three groups was primarily done on the basis of the text the school system had been using for three years previous to the 1965 eighth grade year. In other words, the texts the student used in grades 5,6, and 7 were identified as being either traditional, transitional or modern. The assignment of the texts and the school systems into one of these four groups was done by Mr. Fernand Prevost, Director of Mathematics Education, New Hampshire State Department of Education. This classification is, at best, a very subjective one but the following have been used as working definitions for this study of modern, traditional and transitional mathematics:

Working Definitions for Classifying Schools Based on Texts

If the mathematics text used by the school showed no deviation from methods of presentation common in the late 1950's or early 1960's, and introduced a minimal amount of new math, it was judged to be traditional. Such texts were more frequently filled with long exercise sections; little structure or rationale in concept development was emphasized.

Texts which tended to approximate the California strand development were judged to be modern. Such texts placed stress on the development of concepts and concrete manipulations. Texts emphasizing mathematical systems, properties, functions and graphing, for example, met the criteria for modern.

Those texts which the publisher had admitted, or which Mr. Prevost judged, to have a middle of the road approach were considered transitional. These texts were somewhere along the continuum of traditional to modern.

Where a school system did not fit into a category it was eliminated from the study.

Using the raw scores on the Otis-Gamma intelligence tests, a one-way analysis of variance was computed looking for differences among these three groups. (Ferguson, 1959). This analysis indicated there was a significant difference in mean raw scores among the three groups. The computed F was 14.81 which is significant beyond the .01 level. Following the analysis of variance, T tests were run among the three groups on their intelligence scores. The results of this analysis indicated there was a significant difference in intelligence beyond the .01 level between students in the modern mathematics group and those in the traditional mathematics group, favoring the modern group. It was found that there was a significant difference at the .01 level between those students studying modern mathematics and those studying transitional mathematics, again favoring the modern group. It was found there was a significant difference at the .05 level between those students studying traditional mathematics and those studying traditional mathematics, favoring



the transitional group. The means, as well as the computed F's and T's, are given in Table 1.

The same procedure was followed in looking for significant differences among the three groups in the area of mathematics, as measured by the Metropolitan Achievement Test, using the computation and concepts subtests of the battery. The analysis of the computation scores on the Metropolitan Achievement Test indicated there was a significant difference among the means for computational abilities of the three groups. The computed F was 6.87 which is significant beyond the .01 level.

Following the analysis of variance, T tests were run between the three groups on their computation scores. There was a significant difference between the modern mathematics group and the traditional group which was significant at the .01 level. There was a significant difference between the modern mathematics students and the transitional students at the .05 level. There was a significant difference between the traditional students and the transitional students which was significant at the .05 level. The means as well as the computed F's and T's are given in Table 2.

The data from the Metropolitan Achievement Test, subtest Mathematical Concepts, was also analyzed but no significant difference was found among the three groups. The reported F is .99. The means as well as the computed F are given in Table 3.

The results of these two analyses indicate that there was a significant difference among the three groups based on their IQ. The difference favored the students studying modern mathematics, followed by those studying transitional mathematics, followed by those studying traditional mathematics. When one looks at the differences in computational ability one finds here, too, there is a significant difference, only in reverse. The students who have studied traditional mathematics did significantly better than those who studied transitional mathematics and those who studied modern mathematics. Those who studied transitional mathematics did better than those who studied modern mathematics.



Table 1

A COMPARISON OF MEANS FOR THE OTIS QUICK-SCORING MENTAL ABILITIES TEST: GAMMA

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL	
Number of Students	1215	591	2376	
OTIS Means	36.69	33.59	34.70	

Analysis of Variance

F = 14.81

.01 level of significance 4.60

T Tests	Modern : Trad.	Modern : Trans.	Traditional: Transitional
	4.96	4.27	2.15
Significant	.01	.01	.05



Table 2

A COMPARISON OF MEANS FOR THE METROPOLITAN ACHIEVEMENT TEST: COMPUTATION

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1.215	591	2376
COMPUTATION Means	28.56	30.08	29.22

Analysis of Variance

 $\mathbf{F} = 6.87$

.01 level of significance 4.60

T Tests	Modern : Trad.	Modern : Trans.	Traditional: Transitional
	3.65	2.26	2.26
Significant	.01	.05	.05

Table 3

A COMPARISON OF MEANS FOR THE METROPOLITAN ACHIEVEMENT TEST: MATHEMATICAL CONCEPTS

<u>Fall 1965</u>

, , , , , , , , , , , , , , , , , , ,	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
MATHEMATICAL CONCEPTS Means	29.17	29.34	28.87
Analysis of Variance	 -		
F = .99			
Not Significant			

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In the fall of 1967 the statewide eighth grade testing program was again conducted. This is the tenth consecutive year of this program and the fifth year of this particular study. The tests used in the 1967 testing at grade eight were the following: The School and College Ability Test, Form 3B and the Stanford Achievement Test, Advanced Form W. The tests used in the eighth grade testing program had been changed subsequent to the 1965 testing because it was felt that the Stanford Achievement Test might more adequately measure students' ability in arithmetic computation. It was a much more recently normed test than the Metropolitan and therefore hopefully would reflect more of the "modern Mathematics material" and thereby give a more honest picture of what New Hampshire's students' abilities were, in the area of mathematical computation.

It is noted in the 1967 report of the eighth grade testing program, edited by Dr. Gilbert Austin, that mathematics computation has continued to drop. In 1966, using the Stanford, the median grade equivalent had dropped to 7.8. In 1967, again using the Stanford, it had dropped to 6.8. Because of this very significant drop, in terms of grade equivalents, from 1963 - 1967, (the median grade equivalent, in 1963, using the Metropolitan, being 8.8; the median grade equivalent, in 1967, using the Stanford, being 6.8--a two-year drop in terms of grade equivalents --) it was decided by the author that a replication of the 1965 study would be appropriate to see whether there still were significant differences in the intellectual ability as well as the computational ability of students in grade 8, again classified by the kind of textbooks they were using. It should be noted here, in terms of the grade equivalents just mentioned above, that it is not truly possible to compare grade equivalents based on the Metropolitan with grade equivalents based on the Stanford since there are serious norming problems in terms of the two different tests. The technical supplement provided by Harcourt, Brace and World, equating these two tests in terms of grade equivalents, provides the following data: the 1963 grade equivalent of 8.8 on the Metropolitan is equated with an 8.6 grade equivalent on the Stanford. done using the 1963 data. If one uses the 1967 data and goes in the opposite direction and takes the Stanford Achievement Test grade equivalent in arithmetic computation which is 6.8, and looks up the Metropolitan grade equivalent, one finds it at 7.5. Therefore we have two possible ways of viewing this One may subtract the 1967 equated Metropolitan score from the 1963 Metropolitan grade equivalent; this subtraction, which is 8.8 (1963), minus 7.5, (1967) leaves, in the five year period, a 1.3 year grade equivalent drop. If one uses Stanford to do the subtraction, then one finds he must subtract the 1967 median grade equivalent of the Stanford of 6.8 from the 1963 Stanford grade equivalent of 8.6. This subtraction yields a drop in grade equivalent scores of 2 years.

The following is a discussion of how the replication of the study was conducted. The principal investigator and Mr. Fernand Prevost, Mathematics Consultant for the State Department of Education (New Hampshire) who had worked together on the original study in 1965, spent a considerable amount of time working on the question of the classifying of the schools in this eighth grade population into four groups: traditional, transitional, modern and other. It was finally decided that the best way to do this would be to create a questionnaire



for the schools covering the 5th, 6th and 7th grades. This questionnaire would list all of the presently available commonly used mathematics textbooks. Mr. Prevost agreed to develop this mathematics text list from which a questionnaire was created. A sample of this questionnaire may be found in the appendix of this report. The questionnaire for grades five and six included 17 texts; the questionnaire for grade seven included 13 texts. A total of 107 questionnaires were mailed to the school systems participating in the 1967 grade 8 testing program. Of this number, 91 questionnaires were returned. This represents a percentage return of 85%. Having collected the data from the schools, information was compiled and sent to Mr. Prevost for further refinement and for the categorization of the school systems into one of four groups. In assigning school systems into one of the four groups, Mr. Prevost used essentially the definitions of modern, traditional and transitional which were used in 1965 and which were reported earlier in this study. that selection was completed the data was statistically analyzed in the following manner: a complete analysis of variance was done across each of the three groups using the School and College Ability Test and the Stanford Achievement Test. The following are the results of that analysis.

There was a significant difference among the three groups as measured by the School and College Ability Test on their verbal skills, F = 18.53; their quantitative skills, F = 15.71; and their total score, F = 19.88. All of these differences favored the modern group. Following this analysis a series of T tests was conducted and it was found there was a significant difference between the modern and traditional group and the modern and transitional group on all of the tests except the SCAT Quantitative, in which there was no difference between the modern and the traditional students. The differences between the traditional and the transitional group were not significant. The means as well as the computed F's and T's are given in Table 4.

There was a significant difference among the three groups as measured by the first three tests of the Stanford Achievement Test; these tests being Paragraph Meaning, Spelling and Language tests. The computed F's are: 20.50 for Paragraph Meaning; 11.91 for Spelling; 13.98 for Language. The means for these three subtests all favor the modern group. Following this analysis a series of T tests was conducted and it was found that on Paragraph Meaning there was a significant difference between the modern and traditional groups and the modern and transitional group. There was a non-significant difference between the traditional and the transitional group.

On Stanford Spelling there was a non-significant difference between the modern and the traditional group, a significant difference between the modern and the transitional group and a non-significant difference between the traditional and the transitional group. On Stanford Language there was a significant difference between the modern group and the traditional group and between the modern and the transitional group. There was a non-significant difference between the traditional and the transitional group. The means as well as the computed F's and T's are given in Table 5.

There was a significant difference among the three groups as measured by the three Arithmetic subtests of the Stanford, these tests being Arithmetic



Computation, Arithmetic Concepts and Arithmetic Applications. The computed F for Arithmetic Computation is 11.78; for Concepts, it is 19.95 and for Applications it is 15.01. Following this analysis a series of T tests was conducted and it was found that on Arithmetic Computation there was a nonsignificant difference between the modern and the traditional group, a significant difference between the modern and the transitional group and a significant difference between the traditional and the transitional group. It should be noted here that this difference favored the modern group. On the Concepts subtest there was a significant difference between the modern and the traditional group and between the modern and the transitional There was a non-significant difference between the traditional and the transitional group. This difference favored the modern group. On the Applications subtest of the Stanford there was a non-significant difference between the modern and the traditional group, a significant difference between the modern and the transitional group and a non-significant difference between the traditional and the transitional group. It should be noted that this difference favored the modern group. The means as well as the computed F's and T's are given in Table 6.

There was a significant difference among the three groups as measured by the Stanford Social Studies Test and as measured by the Stanford Science Test. The F for Stanford Social Studies was 9.89 and for Stanford Science 12.81. Following this analysis a series of T tests was conducted and it was found that on Stanford Social Studies there was a significant difference between the modern and traditional group and between the modern and the transitional group. There was a non-significant difference between the traditional group and the transitional group. On Stanford Science there was a significant difference between the modern and the transitional group. There was a non-significant difference between the traditional and the transitional group. The difference in the means in all cases favored the modern group. The means as well as the computed F's and T's are found in Table 7.

It is interesting to note that in the 1967 study of the eighth grade we find that the pattern is totally consistent. The modern group is not only intellectually superior as it was in the 1965 group, but it is also academically superior as measured by the 8 subtests of the Stanford Achievement Test. Of particular interest, it is academically superior in the area of mathematics, in all three cases, Computation, Concepts and Applications.

Table 4

A COMPARISON OF SCHOOL AND COLLEGE ABILITY TEST

<u>GRADE</u> 8: <u>Fall</u> <u>1967</u>

	SCAT Verbal	SCAT Quantitative	SCAT Total	
Modern Mean Group 1	32.60	21.89	54.49	
Traditional Mean Group 2	30.06	21.21	51.27	
Transitional Mean Group 3	30.62	20.45	51.06	
F's	18.528	15.713	19.875	
Significant	.01	.01	.01	
T's and Significance				
1 : 2 =	4.358 .0	1.689 NS	3.599 .01	
1 : 3 =	5.325 .0	5.607 .01	5.994 .01	
2 : 3 =	0.940	NS 1.853 NS	0.222 NS	

Table 5

A COMPARISON OF STANFORD PARAGRAPH MEANING, SPELLING AND LANGUAGE TESTS

GRADE 8: Fall 1967

	Stanford P.M.	Stanford Spelling	Stanford Language
Modern Mean Group 1	34.05	30.53	95 .77
Traditional Mean Group 2	31.74	29.74	93.69
Transitional Mean Group 3	31. 96	28.78	92.47
F's	20.507	11.914	13.980
Significant	•01	.01	.01
T's and Significance			
1 : 2 =	4.151 .01	1.402 NS	2.114 .05
1:3=	5.869 .01	4.881 .01	5.254 .01
2 : 3 =	0.396 NS	1.682 NS	1.219 NS

Table 6

A COMPARISON OF STANFORD ARITHMETIC: COMPUTATION, CONCEPTS AND APPLICATIONS TESTS

GRADE 8: Fall 1967

	Stanford Computation	Stanford Concepts	Stanford Applications	, e
Modern Mean Group 1	19.00	20.50	14.94	
Traditional Mean Group 2	18.75	18.80	14.65	de a populación e
Transitional Mean Group 3	17.81	19.22	14.42	
F's	11.775	19.952	5.012	***************************************
Significant	.01	.01	.01	
T's and Significan	ce		ette s. Kristinathaletinistenet j. Adath ette etti 149-autoritidik 150-augunteniin säälingigang sak	Maga Maga Angli e
1 : 2 =	0.633 NS	4.641 .	01 1.103 NS	
1 : 3 =	4.787 .01	5.448 .	01 3.160 .01	
2 : 3 =	2.376 .05	1.134	NS 0.902 NS	

Table 7

A COMPARISON OF STANFORD SOCIAL STUDIES AND SCIENCE TESTS

GRADE 8: Fall 1967

pagandan namandan yang ayah mahaman manga baga gana kapadan gang dan dalam dalam dalam dalam dalam dalam dalam Mili Jangandan yang dalam	Stanford Social Studies	gerringgaring die verwangs einegschilliche des eines George des eines der Verwangste einschiller des des eines George Grenne d. Verwangste einschiller des des	Stanford Science	gana norozgansky (14844) (5 * 1 4846 14 - Harris Harris (1484) (5 * 1484) 14 - Harris (1484) (5 * 1484)
Modern Hean Group 1	48.16		33.02	
Traditional Hean Group 2	46.22	and the second s	31.72	
Transitional Mean Group 3	46.38		31.60	
F's	9.894		12.813	
Significant	.01		.01	
T's and Significan	ce			a para di santa di s
1 : 2 =	2.846	.01	2.827 .01	
1:3=	4.097	.01	4.839 .01	
2 : 3 =	0.227	MS	0.255 NS	

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In the mathematical development of the analysis of variance, a number of assumptions are made. One assumption is that the distribution of variables and the polulation from which the samples are drawn are normal. Since this study is not based upon the drawing of a sample from a population, but is, in fact, a population itself, the use of analysis of variance can seriously be questioned. Because of the failure to meet this requirement, the project director, in consultation with other statisticians, decided that to pursue the project as originally proposed, the analysis of co-variance for the 1965-67 study would be inappropriate since the assumptions for simple analysis are not met. The assumptions are certainly not met for the analysis of co-variance; therefore, it was decided that the 1967 grade 8 data would be subjected to further analysis by computing selected percentile ranks as a basis for determining differential effects for above and below average students.

Five selected percentiles were chosen for this study: they are the 90th, 75th, 50th, 25th, and 10th. The comparisons that are provided in the following tables indicate the raw scores at each of these selected percentiles for the students involved in the study. In the entire state in 1967 there were 7,139 students tested. In this study there were 4,658. Of that number, 2,269 were classified as modern; 514 were classified as traditional; and 1,875 were classified as transitional. Tables 8 - 11 present the comparisons for these three groups in terms of selected percentiles. We have also prepared normal percentile charts which visually present the same information. These will be found in the following charts, I - XI.

Table 8 and Chart I clearly indicate that we are dealing with three distinct populations, at least as measured by the SCAT Verbal portion of this test. Only at the 75th percentile do the traditional and transitional groups attain the same scores. Other than that, the modern group performance is superior to the transitional and the transitional superior to the traditional group. On the SCAT Quantitative test the picture is not quite as clear. At the 10th, 25th, and 50th percentiles the modern group separates and becomes the superior group. The transitional group starts off more poorly than either the modern or the traditional group and only at the 90th percentile crosses the traditional group's line and has the superior score. On the SCAT Total test the modern group is again clearly different from the other two The traditional and transitional group overlap at the 25th and 75th percentiles. The results of this analysis on the School and College Ability Test would seem to clearly indicate that at all levels the modern group is superior intellectually to the other two groups and that in general the transitional group is superior to the traditional group.

On the first three tests of the Stanford Achievement Test, (Paragraph Meaning, Spelling and Language), the same pattern is consistently followed. The modern and the traditional group at the 10th percentile are equal. At the 25th percentile the traditional group is superior. At the 50th percentile and the 75th percentile they are similar. At the 90th percentile the modern group is clearly superior while the tradi-



group. The transitional group at the 10th, 25th, 50th, and 75th percentile was poorer than either the modern or the traditional group and only at the 90th percentile does it pass the traditional group. On the Stanford Arithmetic Applications subtest there are no differences among any of the three groups at the 10th, 25th or 50th percentile. At the 75th percentile there is no difference between the modern and the traditional group. However, at the 90th percentile the modern group is superior. At the 75th percentile the transitional group is performing more poorly than either of the other two groups; at the 90th percentile it is scoring equally well with the traditional group.

On the Social Studies and the Science subtests of the Stanford the pattern once again re-emerges of the modern group being markedly superior to the other groups. On the Social Studies subtest of the Stanford the modern group is superior at all percentile levels to the other two groups and only at the 25th percentile do the traditional and the modern groups perform equally well on the Science subtest. At all other levels the modern group is superior to the other two. Again, as has been the case in earlier subtests, the traditional and the transitional groups tend to overlap each other at various percentiles.

Table 8

A COMPARISON OF SELECTED PERCENTILES FOR SCHOOL AND COLLEGE ABILITY TEST

<u>GRADE</u> 8: <u>Fall</u> <u>1967</u>

NAME OF TEST	SEL	ECTED PER	CENTILES I	N RAW SC	ORES
	<u>10th</u>	25th	50th	75th	90 t h
SCAT Verbal	•				
Modern Group	16	23	33	41	48
Traditional Group	14	20	29	39	46
Transitional Group	15	21	30	39	47
SCAT Quantitative					
Modern Group	12	15	20	27	3 3
Traditional Group	12	15	20	26	33 31
Transitional Group	10	14	19	25	32
SCAT Total				,	
Modern Group	31	40	54	67	7 9
Traditional Group	29	37	50	64	79 75
Transitional Group	27	37	49	64	75 76
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Table 9

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD PARAGRAPH MEANING, SPELLING, LANGUAGE

GRADE 8: Fall 1967

NAME OF TEST	SELI	ECTED PERC	CENTILES I	N RAW SCO	DRES
	<u>10th</u>	<u>25th</u>	<u>50th</u>	<u>75th</u>	90th
STALFORD Paragraph Meaning					
Modern Group Traditional Group Transitional Group	18 17 16	25 22 23	34 31 31	43 40 40	49 47 47
STANFORD Spelling					
Modern Group Traditional Group Transitional Group	16 15 14	21 21 19	29 28 27	39 37 37	47 46 45
STANFORD Language				Activity States - Control of the Con	
Modern Group Traditional Group Transitional Group	68 66 65	81 77 78	97 95 93	111 109 108	120 120 118

Table 10

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD ARITHMETIC: COMPUTATION, CONCEPTS AND APPLICATIONS TESTS

GRADE 8: Fall 1967

NAME OF TEST	SEL	ECTED PER	CENTILES I	N RAW SC	ORES
	<u> 10th</u>	25th	<u>50th</u>	75th	<u>90th</u>
STANFORD Computation					
Modern Group Traditional Group Transitional Group	9 9 8	12 13 11	18 18 16	24 24 23	30 28 29
STANFORD Concepts					· annual
Modern Group Traditional Group Transitional Group	10 10 9	14 13 13	20 18 18	26 23 24	31 28 29
STANFORD Applications					
Modern Group Traditional Group Transitional Group	8 8 8	10 10 10	14 14 14	18 18 17	22 21 21

Table 11

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD SOCIAL STUDIES AND SCIENCE TEST

GRADE 8: Fall 1967

NAME OF TEST	SEL	SELECTED PERCENTILES IN RAW SCO												
	<u> 10th</u>	<u>25th</u>	<u>50th</u>	75th	90 t h									
STANFORD Social Studies														
Modern Group Traditional Group Transitional Group	29 27 28	37 35 35	48 47 46	59 56 57	66 65 65									
STANFORD Science														
Modern Group Traditional Group Transitional Group	20 19 19	25 25 24	33 31 31	40 38 38	45 43 44									

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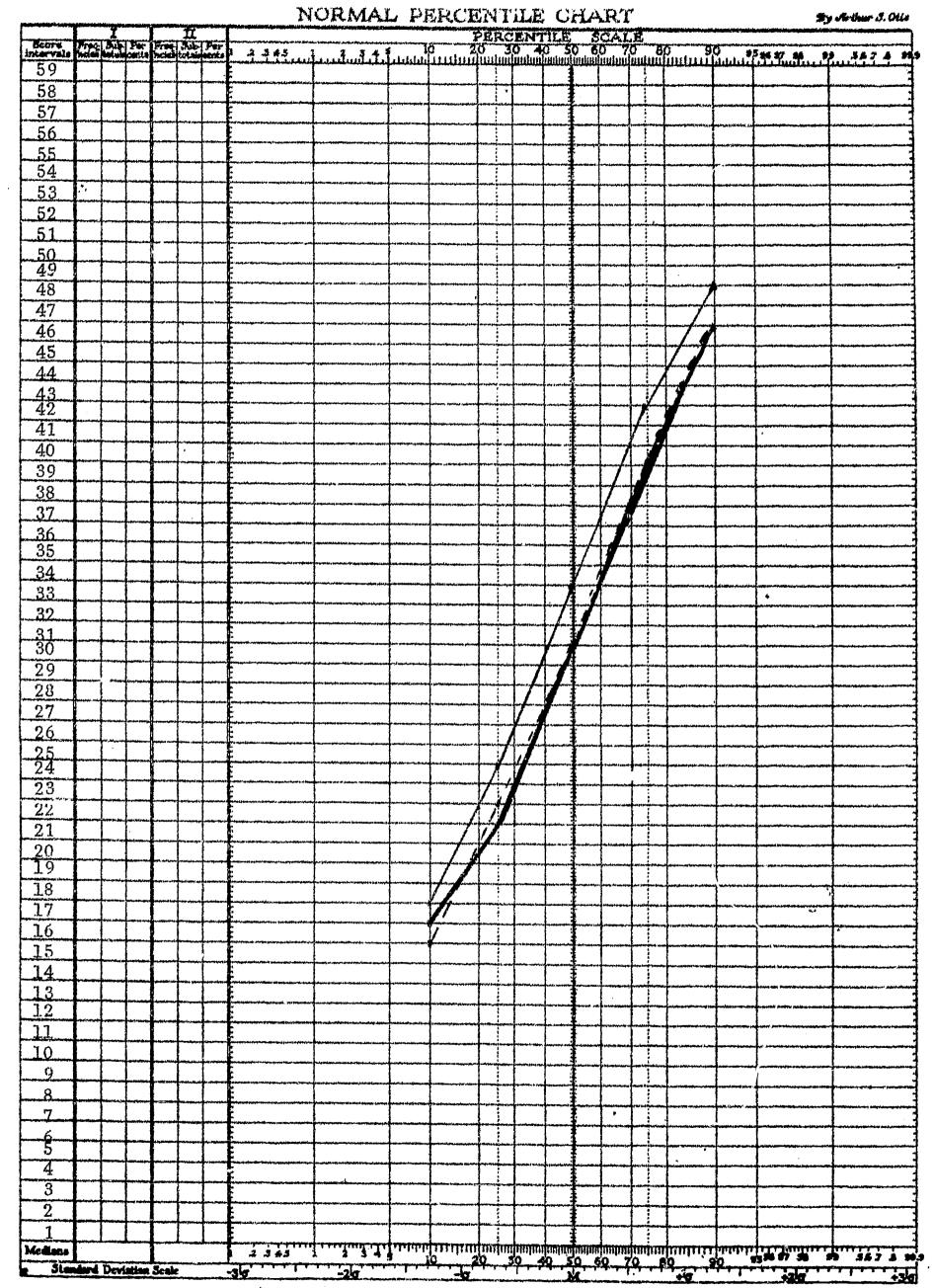
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GRADE 8 MATH STUDY Chart V Fall '67

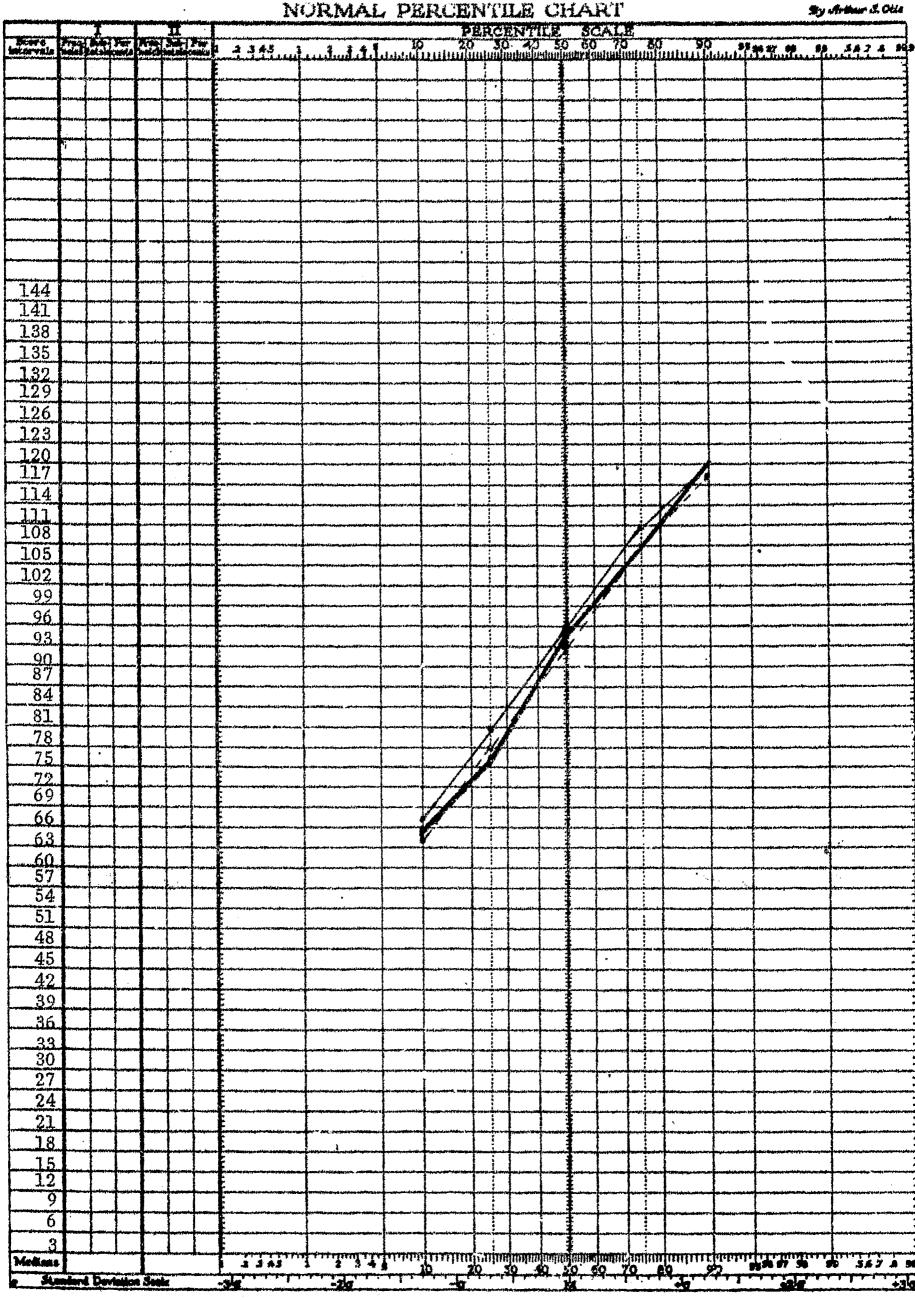
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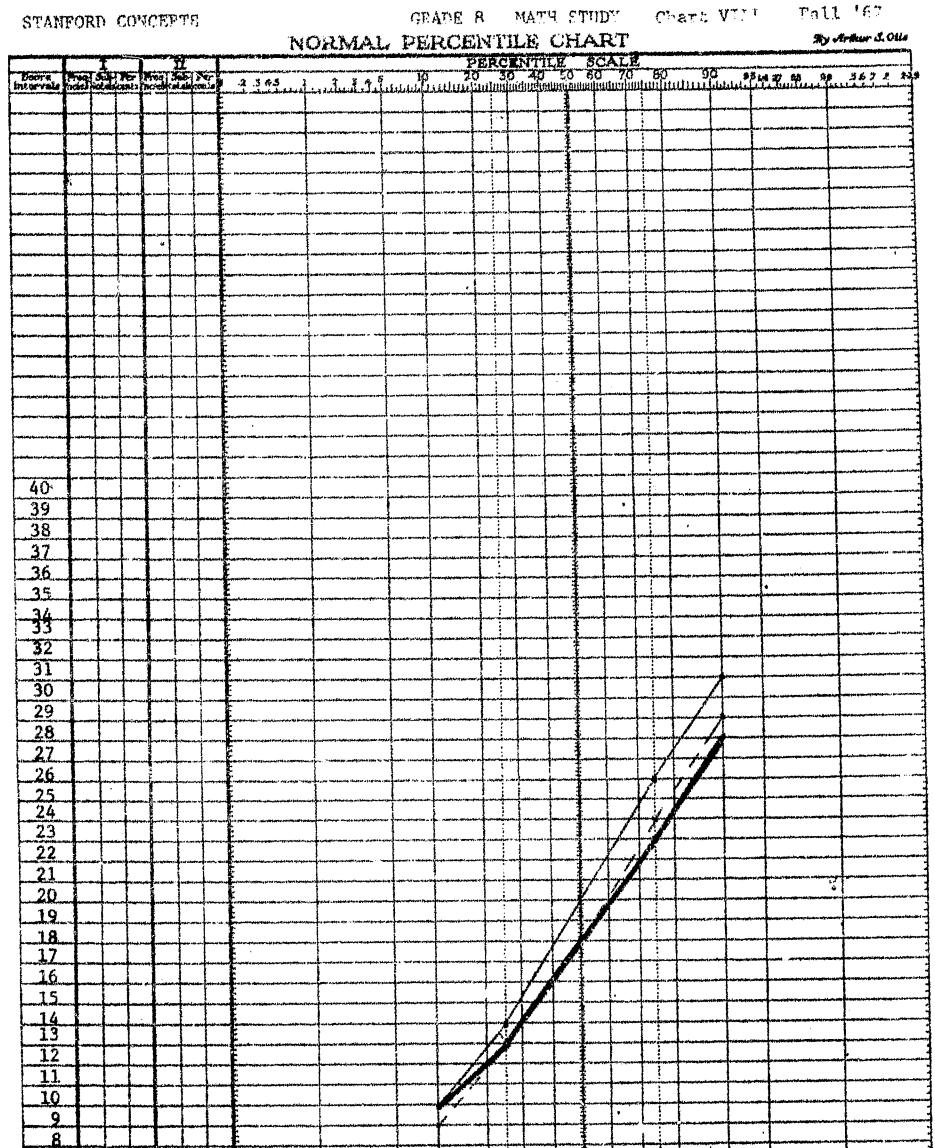
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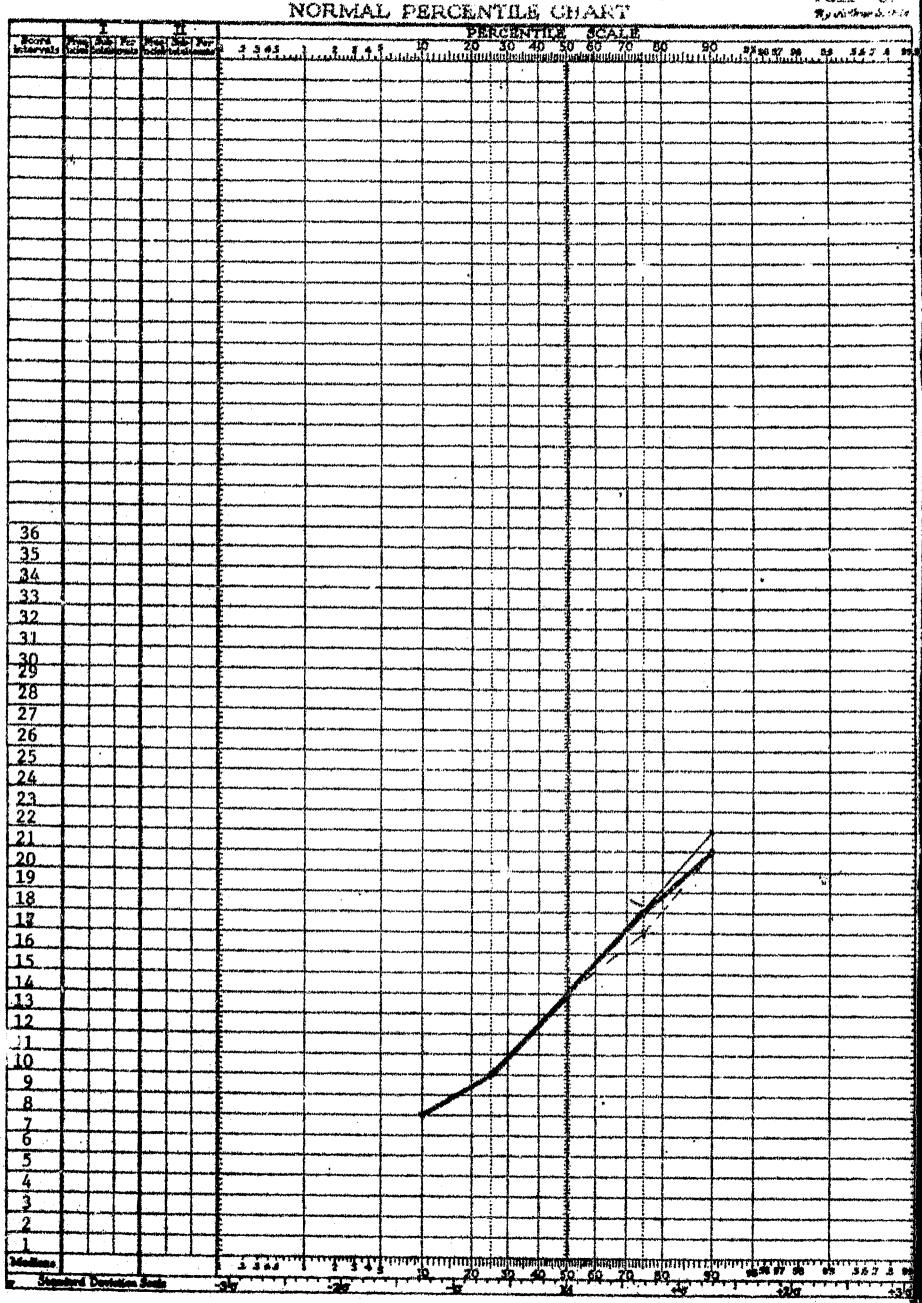


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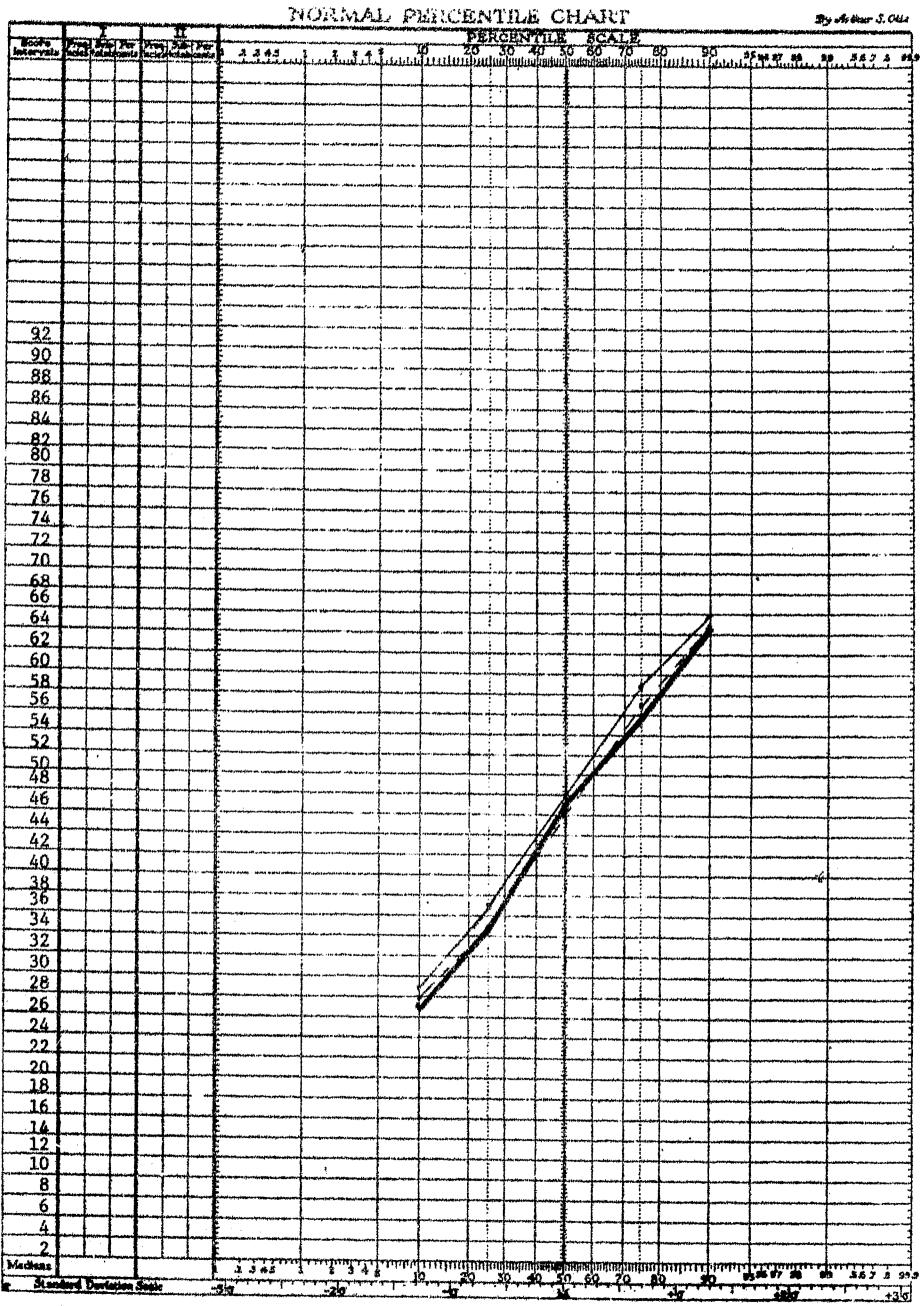
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GRADE 8 MATH STUDY Chart XT Fall '67

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Conclusions

In 1964 it became apparent that there had been a significant drop in the arithmetic computation scores since 1963. This drop continued into 1965 when the first study authorized by the New Hampshire State Department of Education was conducted by the Bureau of Educational The results of that study clearly Research and Testing Services. indicated that for the three groups designated as modern, traditional and transitional, in intellectual skills, as measured by the Otis, the modern group was clearly superior, followed in order by the group classified as being transitional and the group classified as being traditional. Mathematics Computation the exact inverse was true. The traditional group scored highest, followed by the transitional group, followed by the modern group. In 1967 a replication of this study was undertaken by the Bureau of Educational Research and Testing Services. The results of that study clearly indicate that again the group classified as modern is intellectually superior to the groups classified as transitional and traditional as measured by the School and College Ability Test. This finding is substantiated by the same kinds of differences and in the same direction, based on the first three tests of the Stanford Achievement battery, namely Paragraph Meaning, Spelling and Language. This again clearly indicates that the modern group is intellectually superior to the transitional or the traditional group.

On the Arithmetic subtests of the Stanford, (Computation) there seems to be markedly less difference between the modern and the traditional group than between either the modern and the transitional or the traditional and the transitional group. The transitional group seems to be achieving much more poorly than the other two groups. This is not true on the Arithmetic Concepts subtest; there the modern group clearly does better work than either the traditional or the transitional group. On the Stanford Arithmetic Applications subtest there seems to be little difference among any of the three groups at the lower selected percentiles. It is only at the upper end of the continuum that there is any real difference and at that point the modern group is clearly superior to the other two groups. The Social Studies test and the Science test tend to confirm the fact that the modern group is clearly superior to the traditional and transitional groups as they were on the SCAT and the first three subtests of the Stanford.

What seems to be true, as a result of this study, is that we are dealing with three significantly different populations, intellectually, and that the group classified as modern is clearly superior to the other two. In the area of Arithmetic Computation this difference does not hold up. The modern and the traditional group both perform at superior levels to the group classified as transitional. Perhaps this is caused by the fact that students studying in a modern text or a traditional text are at least being instructed in one systematic method while those students being instructed with a transitional text are being somewhat confused by attempting to understand modern mathematics and at the same time being taught traditional mathematics. There does not seem to be any easy explanation for this finding.



One should not lose sight, in this discussion, of the fact that scores obtained by each of these groups on the Stanford Arithmetic Computation subtest in 1967 are markedly lower than they were in 1965 and still lower than in 1963. If we look up those median scores as grade equivalents we find that the modern group and the traditional group have median scores of 18 raw score points, which are equal to grade equivalents of 7.2. The transitional group has a median score of 16 which is equal to a grade equivalent of 6.6. This pattern is similar to one we noted earlier in this paper. We can therefore safely conclude that in five years the computational ability of the students at grade 8 in New Hampshire has markedly declined. We can also reasonably safely conclude that this does not seem to be a function of the kind of textbook they are using in their classes, for this decline is almost equally great for all three groups involved in this study.

The data presented in this study clearly indicate that the type of mathematics text book used does not differentially affect (in 1967, at least) the ability of students to do computational arithmetic. However, it is the author's opinion, based upon lengthy conversations with Mr. Prevost of the State Department of Education as well as a number of teachers in a variety of schools in New Hampshire, that most teachers have in the last several years put more and more emphasis on the understanding of arithmetic and less and less time on meaningful drill and practice in the art of computation. The decline in mathematics computational ability is probably due more to the broad and generalized effect of the insistance on the part of mathematics specialists that understanding of mathematics be given a higher priority than it has been given in the past. It is a general trend in mathematics education, and the present preparation of teachers also contributes in this particular direction. There, also, the general understanding of mathematics has been stressed and so as new teachers have moved out from the training institutions, they have gone out with more concern to teach understandings and less concern with teaching computation. As stated in the beginning of this paragraph, these statements are not supported by hard data, neither are they just ideal specualation. It is suggested that it would be an appropriate kind of follow-up to this study to go and actually look at the classroom behavior of a variety of teachers and attempt to assess whether these statements are, in fact, true.

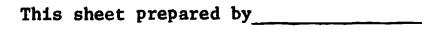
The original proposal for this study proposed that an item analysis should be done on each of the three groups. Because data was available on students who were then in 10th grade, who had been tested in 1965 at eighth grade, it was decided by the project director that he would forego the study of the item analysis and do, instead, two other studies based on computational ability. They are reported under the headings of A Longitudinal Study of Tenth Graders, 1965-1967 and A Study of Abilities and Achievements in Mathematics of Three Groups of Tenth Graders in New Hampshire. The result of those two studies seems to the project director to clearly indicate that this was a wise choice.

APPENDIX



LIST FOR GRADE 5

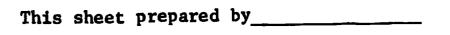
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	Elementary School Mathematics	Addison-Wesley
	Modern Mathematics Series	American Book Company
	Discovering Mathematics	Charles Merrill Company
	GCMP Math Program	Ed. Res. Council of Greater Cl.
	Math Workshop for Children	Encyclopedia Britannica
	Mathematics We Need	Ginn and Company
	Growth in Arithmetic, Discovery Ed.	Harcourt, Brace & World
	Elementary Mathematics	Holt, Rinehart & Winston
-	Modern School Mathematics	Houghton, Mifflin Company
	SRA Elementary Math Program	SRA
	GCMP Math Program	SRA
	Contemporary Mathematics	Sadlier
	Seeing Through Arithmetic	Scott, Foresman & Company
	Sets and Numbers	Singer/Random House
	Modern Math Through Discovery	Silver Burdett Company
	Elementary Mathematics: Concepts, Properties & Operations	Webster, McGraw-Hill
	SMSG Elementary Mathematics	Yale University Press
•.	Other (Please Specify)	





LIST FOR GRADE 6

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	Modern Mathematics Series	American Book Company
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	Math Workshop for Children	Encyclopedia Britannica
-	Mathematics We Need	Ginn and Company
	Growth in Arithmetic, Discovery Ed.	Harcourt, Brace & World
	Elementary Mathematics	Holt, Rinehart & Winston
***************************************	Modern School Mathematics	Houghton, Mifflin Company
	SRA Elementary Math Program	SRA
	GCMP Math Program	SRA
	Contemporary Mathematics	Sadlier
	Seeing Through Arithmetic	Scott, Foresman & Company
nich Stratigebourgebod ¹⁰⁰	Sets and Numbers	Singer/Random House
	Modern Math Through Discovery	Silver Burdett Company
	Elementary Mathematics: Concepts, Properties & Operations	Webster, McGraw-Hill
	SMSG Elementary Mathematics	Yale University Press
	Other (Please Specify)	





LIST FOR GRADE 7

	SERIES NAME	PUBLISHER
	Arithmetic Concepts and Skills	Addison-Wesley
	Basic Modern Mathematics	Addison-Wesley
·····	School Mathematics I	Addison-Wesley
-	Structuring Mathematics	American Book Company
	Mathematics We Need- J-1	Ginn & Company
	Growth in Arithmetic Discovery, Ed. 7	Harcourt, Brace & World
. (144	Elementary Mathematics 7	Holt, Rinehart & Winston
	Exploring Modern Math	Holt, Rinehart & Winston
P The second account of a particular and	Modern School Math -7	Houghton Mifflin Company
	Math for Jr. High School, Vol. I	SMSG-Yale Press
-et-re-indulated viril conspinues	Contemporary Mathematics, 7	Sadlier
	Seeing Through Mathematics I	Scott, Foresman Company
	Modern Math Through Discovery I	Silver Burdett Company
	Other (Please Specify)	

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Footnotes

¹Durost, Walter N. Report and Summary. New Hampshire Statewide Grade Eight Testing Program. Concord, New Hampshire: Test Service and Advisement Center, November, 1964, p.9.



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A LONGITUDINAL EVALUATION OF MATHEMATICAL COMPUTATIONAL ABILITIES

OF NEW HAMPSHIRE'S EIGHTH GRADERS (1965) AND TENTH GRADERS (1967)

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List of Normal Percentile Charts

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IV	Reading Vocabulary	20
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In the fall of 1965 the Bureau of Educational Research and Testing Services at the University of New Hampshire conducted the eighth consecutive yearly statewide testing program at grade eight for the New Hampshire State Department of Education. The program consisted of a mental abilities test, the Otis form Fm and the Metropolitan Achievement Test, battery form Am.

The research reported in this paper was conducted with the sponsorship of the New Hampshire State Department of Education and a grant from the United States Office of Education, Grant No. OEG-1-9-090023-0106(010). The purpose of the research was to evaluate empirically the effects of using different mathematics text books on the mathematical computational ability of students as a method of assessing the effectiveness of different mathematics instruction, based primarily on a text.

For about a year previous to 1965 there had been a growing level of concern about dropping mathematics computation scores as measured by the Metropolitan Achievement Test. In his 1964 report, Dr. Walter Durost said:

"It is suspected that the adoption of the new curriculum in mathematics in New Hampshire may have resulted in the drop in Arithmetic Computation. This influence has been noted in other studies in communities where data are available over a period of years and where the new curriculum has recently been introduced." (Durost, 1964)

In 1965 the total number of students tested in the state was 4,724. this number, 4,182 were included in the study. The eighth grade classes which participated in this voluntary statewide testing program were placed in one of four categories which were designated as follows: modern, traditional, transitional and other. 5 42 students were eliminated from the study by being placed in the category called other. Placement in these groups was done primarily on the basis of the text the school system had been using for three years previous to the 1965 eighth grad? year. In other words, the texts the student used in grades 5,6 and 7 were identified as being either traditional, transitional or modern. assignment of the texts and the school systems into one of these four groups was done by Mr. Fernand Prevost, Director of Mathematics Education, New Hampshire State Department of Education. This classification is, at best, a very subjective one but the following have been used as working definitions for this study of modern, traditional and transitional mathematics:

Working Definitions for Classifying Schools Based on Texts

If the mathematics text used by the school showed no deviation from methods of presentation common in the late 1950's or early 1960's, and introduced a minimal amount of new math, it was judged to be traditional. Such texts were more frequently filled with long exercise sections; little structure or rationale in concept development was emphasized.



Texts which tended to approximate the California strand development were judged to be modern. Such texts placed stress on the development of concepts and concrete manipulations. Texts emphasizing mathematical systems, properties, functions and graphing, for example, met the criteria for modern.

Those texts which the publisher had admitted, or which Mr. Prevost judged, to have a middle of the road approach were considered transitional. These texts were somewhere along the continuum of traditional to modern.

Where a school system did not fit into a category it was eliminated from the study.

Using the raw scores on the Otis-Gamma intelligence test. a one-way analysis of variance was computed looking for differences among these three groups. (Ferguson, 1959). This analysis indicated there was a significant difference among the mean raw scores for these three groups. The computed F was 14.81 which is significant beyond the .01 level. Following the analysis of variance, T tests were run among the three groups on their intelligence scores. The results of this analysis indicated there was a significant difference in intelligence beyond the .01 level between students in the modern mathematics group and those in the traditional mathematics group, favoring the modern group. It was found that there was a significant difference at the .01 level between those students studying modern mathematics and those studying transitional mathematics, again favoring the modern group. It was found there was a significant difference at the .05 level between those students studying traditional mathematics and those studying transitional mathematics, favoring the transitional group. The means, as well as the computed F's and T's, are given in Table 1.

The same procedure was followed in looking for significant differences among the three groups in the area of mathematics, as measured by the Metropolitan Achievement Test, using the Computation and Concepts subtests of the battery. The analysis of the Computation scores on the Metropolitan Achievement Test indicated there was a significant difference among the mean computational abilities for the three groups. The computed F was 6.87 which is significant beyond the .01 level. Following the analysis of variance, T tests were run between the three groups on their computation scores. There was a significant difference between the modern mathematics group and the traditional group which was significant at the .01 level. There was a significant difference between the modern mathematics students and the transitional students at the .05 level. There was a significant difference between the traditional students and the transitional students which was significant at the .05 level. The means as well as the computed F's and T's are given in Table 2.

The data from the Metropolitan Achievement Test, subtest Mathematical Concepts, was also analyzed but no significant difference was found among



the three groups. The reported F is .99. The means as well as the computed F are given in Table 3.

The results of these two analyses indicate that there was a significant difference among the three groups based on their IQ. The difference favored the students studying modern mathematics, followed by those studying transitional mathematics, followed by those studying traditional mathematics. When one looks at the differences in computational ability one finds here, too, there is a significant difference, only in reverse. The students who have studied traditional mathematics did significantly better than those who studied transitional mathematics and those who studied modern mathematics. Those who studied transitional mathematics did better than those who studied modern mathematics.

Table 1

A COMPARISON OF MEANS FOR THE OTIS QUICK-SCORING MENTAL ABILITIES TEST: GAMMA

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
OTIS Means	36.69	33.59	34.70

Analysis of Variance

F = 14.81

.01 level of significance 4.60

T Tests	Modern : Trad.	Modern : Trans.	Traditional : Transitional
	4.96	4.27	2.15
Significant	.01	.01	.05



Table 2

A COMPARISON OF MEANS FOR THE METROPOLITAN ACHIEVEMENT TEST: COMPUTATION

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
COMPUTATION Means	28.56	30.08	29.22

 $\mathbf{F} = 6.87$

.01 level of significance 4.60

T Tests	Modern : Trad.	Modern : Trans.	Traditional : Transitional
	3.65	2.26	2.26
Significant	.01	.05	.05

Table 3

A COMPARISON OF MEANS FOR THE METROPOLITAN ACHIEVEMENT TEST: MATHEMATICAL CONCEPTS

Fall 1965

	MODERN	TRADITIONAL	TRANSITIONAL
Number of Students	1215	591	2376
MATHEMATICAL CONCEPTS Means	29.17	29.34	28.87

Analysis of Variance

F = .99

Not Significant

In the fall of 1967 when these same students were now in 10th grade they were involved in another statewide testing program. In 1967, 9,776 10th graders participated in the statewide testing program. Of this number, 3,439 students were involved in the follow-up study. It should be noted that traditionally many more school systems participated in the 10th grade testing program than in the 8th and this accounts for the large discrepancy. It should also be noted that due to population loss and the difficulty of classifying high schools there was a loss of students between the original 8th grade population and the 10th grade population.

The 10th grade battery consisted of the School and College Ability Test, Form 2B; the Cooperative English Test, Form 2C; the Stanford High School Numerical Competence Test, Form X; the Stanford High School Mathematics Test, Form X, Part A and B. It was decided to use the same procedures as had been used two years earlier, when the students were in the 8th grade, to conduct the study.

Having divided the children into three groups, again classified as modern, traditional and transitional, the following analyses were conducted: a complete analysis of variance was done across the three groups using the School and College Ability Test, the Cooperative English Test, the Stanford Numerical Competence Test and the Stanford High School Mathematics Test, Part A and B. The following are the results of those computations.

There was a significant difference among the three groups as measured by the Verbal portion of the School and College Ability Test; F=9.6. There was no significant difference among the three groups as measured by the School and College Ability Test, Quantitative, F=1.5. There was no significant difference among the three groups as measured by the School and College Ability Test, Total: F=2.39. Following this analysis a series of T tests was conducted and it was found there was a significant difference on Verbal skills between modern and traditional groups and the modern and transitional groups. There was a non-significant difference between the traditional and the transitional group. The means as well as the computed F's and F's are given in Table 4.

There was a significant difference among the three groups as measured by the Vocabulary portion of the Cooperative English Test; F=5.132. There was no significant difference in Reading Level; F=2.94. There was no significant difference in Reading Speed; F=2.10. There was a significant difference among the three groups in terms of English Expression; F=5.57. Following this analysis, a series of T tests was conducted and it was found that on Reading Vocabulary there was a significant difference between modern and traditional groups and the modern and transitional groups. There was no significant difference between the traditional group and the transitional group. There was no significant difference among the three groups on Reading Level and Reading Speed.

On Reading Total there was a significant difference between the modern and traditional group and between the modern and transitional group. There was a non-significant difference between the traditional and the transitional group. On English Expression, there was a significant difference between the modern and the traditional group, and the modern and transitional group. There was a non-significant difference between the traditional and transitional group. The means as well as the computed F's and T's are given in Table 5.

An analysis of variance based on Numerical Competence was computed and it was found there was a non-significant difference. There was a very significant difference at the .01 level with an F of 19.58 for Mathematics subtest A of the Stanford. We find here that there is a significant difference between the modern and traditional group, a non-significant difference between modern and transitional and again a significant difference between transitional and traditional. The means as well as the computed F's and T's are given in Table 6.

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Table 4

A COMPARISON OF SCHOOL AND COLLEGE ABILITY TEST

Fall 1967

	SCAT Verbal	Oı.	SCAT uantitative		SCAT Total	
Modern Mean Group 1	31.87		28.60		60.46	
Traditional Mean Group 2	29.23		28.93		58.16	
Transitional Mean Group 3	30.36		29.18		59.48	
F's	9.560		1.488		2.385	
Significant	.01		ns		NS	
T's and Significance					7/2	
1 : 2 =	3.888	.01	0.641	NS	2.110	ns
1:3=	3.427	.01	1.722	NS	1.393	NS
2 : 3 =	1.771	NS	0.505	NS	1.282	ns

A COMPARISON OF COOPERATIVE ENGLISH TEST

Table 5

Fall 1967

	Reading Vocab	Reading Level	Reading Speed	Reading Total	English Expression
Modern Mean Group 1	35.54	18.56	29.44	64.79	45.08
Traditional Mean Group 2	34.04	18.22	28.47	62.50	42.88
Transitional Mean Group 3	34.51	18.07	28.69	63.13	44.04
F's	5.132	2.937	2.102	3.240	5.571
Significant	.01	NS	ns	.05	.01
T's and Significanc	e				
1 : 2 =	2.614 .01	1.093 NS	1.569 NS	2.011 .05	3.160 .01
1:3=	2.766 .01	2.426 NS	1.852 NS	2.254 .05	2.300 .05
2 : 3 =	0.870 NS	0.514 NS	0.388 NS	0.582 NS	1.770 NS

Table 6

A COMPARISON OF STANFORD NUMERICAL COMPETENCE AND MATHEMATICS A TESTS

<u>Fall 1967</u>

	Numerical Competence	Mathematic A	
Modern Mean Group 1	27.04	26.09	
Traditional Mean Group 2	26.51	19.41	
Transitional Mean Group 3	26.59	25.68	
F's	1.047	19.578	
Significant	ns	.01	
T's and Significance		· · · · · · · · · · · · · · · · · · ·	
1 : 2 =	1.068	NS 6.157	.01
1 : 3 =	1.351	NS 0.783	ns
2 : 3 =	0.183	NS 5.934	.01



In the mathematical development of the analysis of variance, a number of assumptions are made. One assumption is that the distribution of variables and the population from which the samples are drawn are normal. Since this study is not based upon the drawing of a sample from a population, but is, in fact, a population itself, the use of analysis of variance can seriously be questioned. Because of the failure to meet this requirement, the project director, in consultation with other statisticians, decided that to pursue the project as originally proposed, the analysis of co-variance for the 1967 study would be inappropriate, since the assumptions for simple analysis are not met. The assumptions are certainly not met for the analysis of co-variance; therefore, it was decided that the 1967 grade 10 data would be subjected to further analysis by computing selected percentile ranks as a basis for determining differential effects for above and below average students.

Five selected percentile ranks were chosen for this study: they are the 90th, 75th, 50th, 25th, and 10th. The comparisons that are provided indicate the raw scores at these selected percentiles for the students involved in the study, taking the test at grade 10 (3,439 students). We have also prepared normal percentile charts which visually present the same information. Shown are the raw scores for the modern group which numbered 1,107 students; for the traditional group, which numbered 404 students; and for the transitional group, which numbered 1,928 students. These comparisons, as well as comparisons for the entire state, may be studied in Tables 7-10 and normal percentile charts I - X.

The modern mathematics group on SCAT Verbal seems to do markedly better than either of its two comparable groups at the 50th, 75th and 90th percentiles. On the Quantitative subtest there seems to be little difference at the upper percentile levels between the three groups but there does seem to be some degree of difference at the 25th and 10th percentiles favoring the traditional and transitional groups. A similar pattern can be noted on SCAT total as well as on many of the Cooperative English Tests. A similar pattern can be noted also on the Stanford Numerical Competence subtest. On the High School Mathematics Test, Part A, we seem to find a very real and important difference favoring the students studying modern mathematics over those studying traditional mathematics. At the upper selected percentile ranks these differences run between 7 and 8 raw score points, while at the lower selected percentiles the difference is between 5 and 7 points. The transitional group again seems to fall between the two groups at the upper selected percentiles, but exceeds both at the lower selected percentiles.



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Table 7

A COMPARISON OF SELECTED PERCENTILES FOR SCHOOL AND COLLEGE ABILITY TEST

Fall 1967

NAME OF TEST	SELI	ECTED PERC	CENTILES I	N RAW SCO	ORES
	<u> 10th</u>	<u>25th</u>	<u>50th</u>	75th	<u>90th</u>
SCAT Verbal					
Modern Group	15	21	31	4J ,	49
Traditional Group	16	21	28	36	44
Transitional Group	16	21	29	38	47
SCAT Quantitative			,		
Modern Group	15	22	29	35	40
Traditional Group	17	23	29	35	39
Transitional Group	17	23	29	35	40
SCAT Total			The second se	1 2 2 3	
Modern Group	34	45	60	75	86
Traditional Group	36	45	58	69	81
Transitional Group	35	45	59	73	84
					

Table 8

A CCMPARISON OF SELECTED PERCENTILES FOR COOPERATIVE ENGLISH TEST

Fall 1967

NAME OF TEST	SELECTED PERCENTILES IN RAW SCORES										
	<u> 10th</u>	25th	<u>50th</u>	<u>75th</u>	<u>90th</u>						
Reading Vocabulary					•						
Modern Group	21	28	35	43	49						
Traditional Group	23	28	33	39	46						
Transitional Group	22	27	34	41	47						
Reading Level											
Modern Group	10	14	19	22	25						
Traditional Group	11	14	18	21	24						
Transitional Group	10	14	18	22	24						
Reading Speed											
Modern Group	15	20	29	37	44						
Traditional Group'	16	20	28	35	42						
Transitional Group	15	20	28	36	43						
Reading Total											
Modern Group	38	48	65	80	92						
Traditional Group	41	48	61	74	86						
Transitional Group	38	49	62	77	88						
English Expression					and the second s						
Modern Group	28	36	44	54	62						
Traditional Group	28	35	42	50	57						
Transitional Group	28	36	43	51	60						
	· · · · · · · · · · · · · · · · · · ·										



Table 9

A COMPARISON OF SELECTED PERCENTILES FOR STANFORD NUMERICAL COMPETENCE AND MATHEMATICS A TESTS

Fall 1967

NAME OF TEST	SELI	ECTED PERC	CENTILES I	N RAW SCO	ORES	
	<u>10th</u>	<u>25th</u>	<u>50th</u>	<u>75th</u>	<u>90th</u>	
Numerical Competence						
Modern Group Traditional Group Transitional Group	14 16 15	20 21 20	27 27 27	33 32 33	38 36 37	
Mathematics A						
Modern Group Traditional Group Transitional Group	17 12 18	21 14 22	26 19 25	30 23 29	34 26 33	

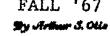
Table 10

A COMPARISON OF SELECTED PERCENTILES FOR 10TH GRADE TESTING PROGRAM: ENTIRE STATE

Fall 1967

NAME OF TEST	SELI	ECTED PERC	CENTILES 1	N RAW SCO	ORES
	<u> 10th</u>	<u>25th</u>	<u>50th</u>	75th	<u>90th</u>
SCAT Verbal	16	21	29	39	47
SCAT Quantitative	16	21	29	35	47
SCAT Total	34	45	58	72	84
Reading Vocabulary	22	28	35	41	47
Reading Level	10	14	18	22	25
Reading Speed	15	20	28	36	43
Reading Total	38	49	64	77	8 9
English Expression	28	35	43	52	59
Numerical Competence	14	20	26	32	37
Mathematics A	16	21	26	31	34

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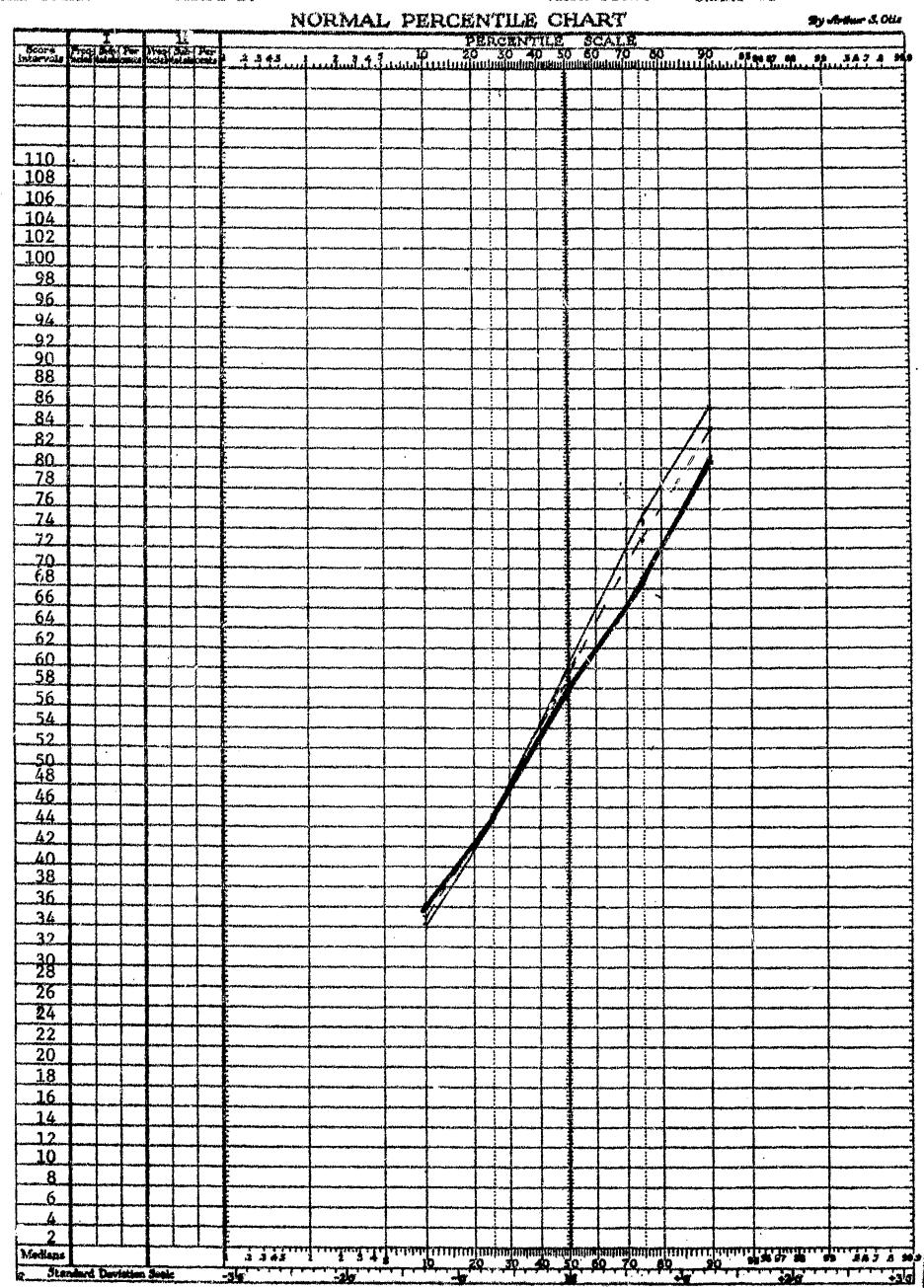
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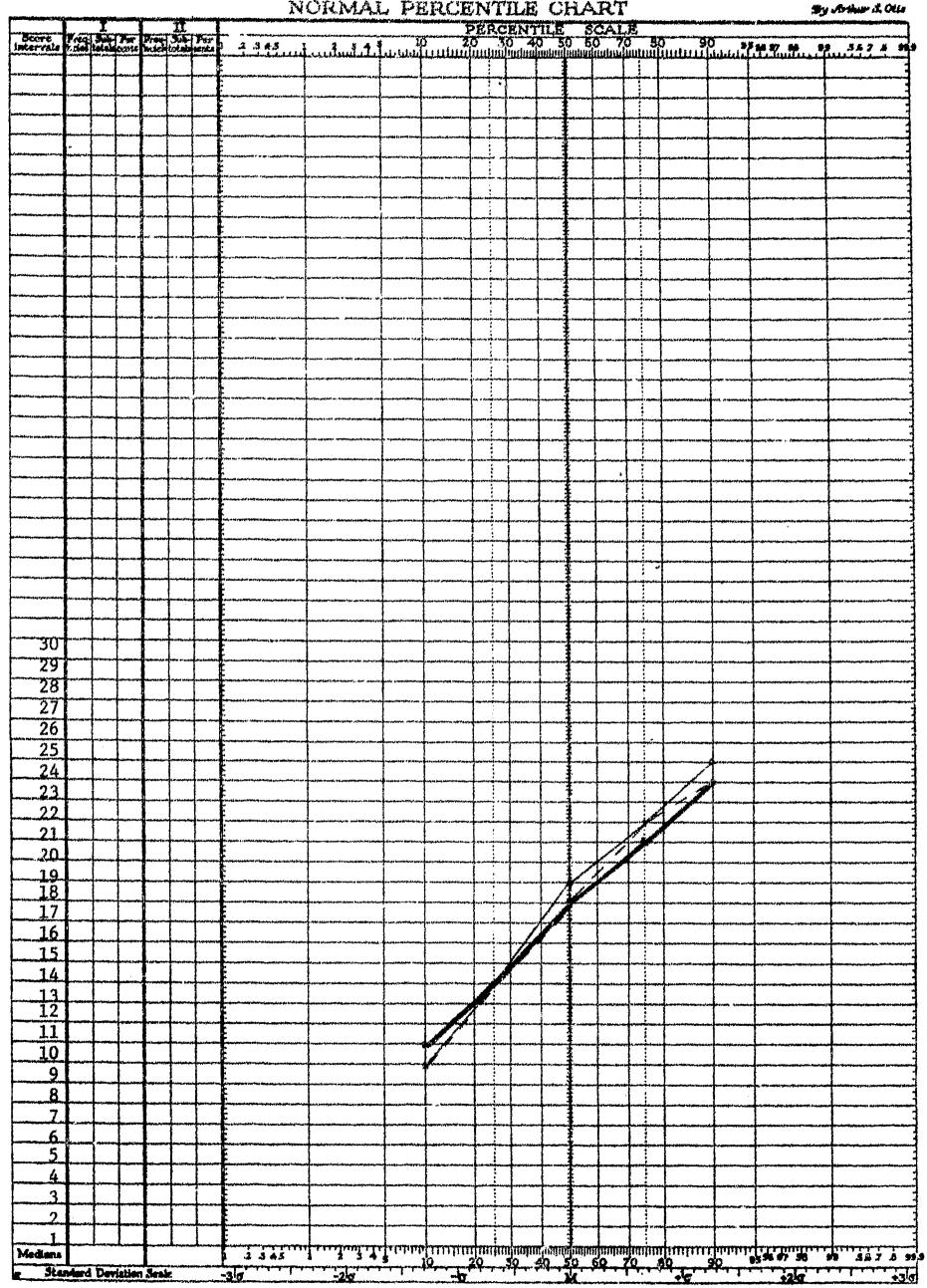
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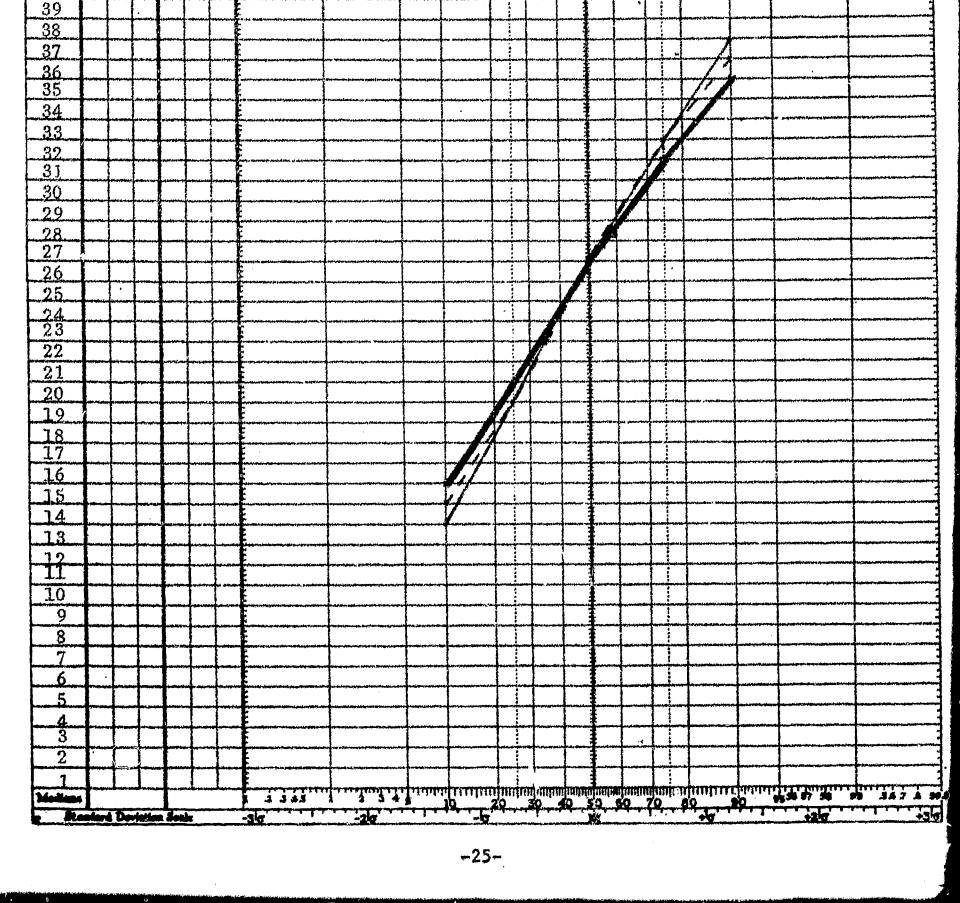


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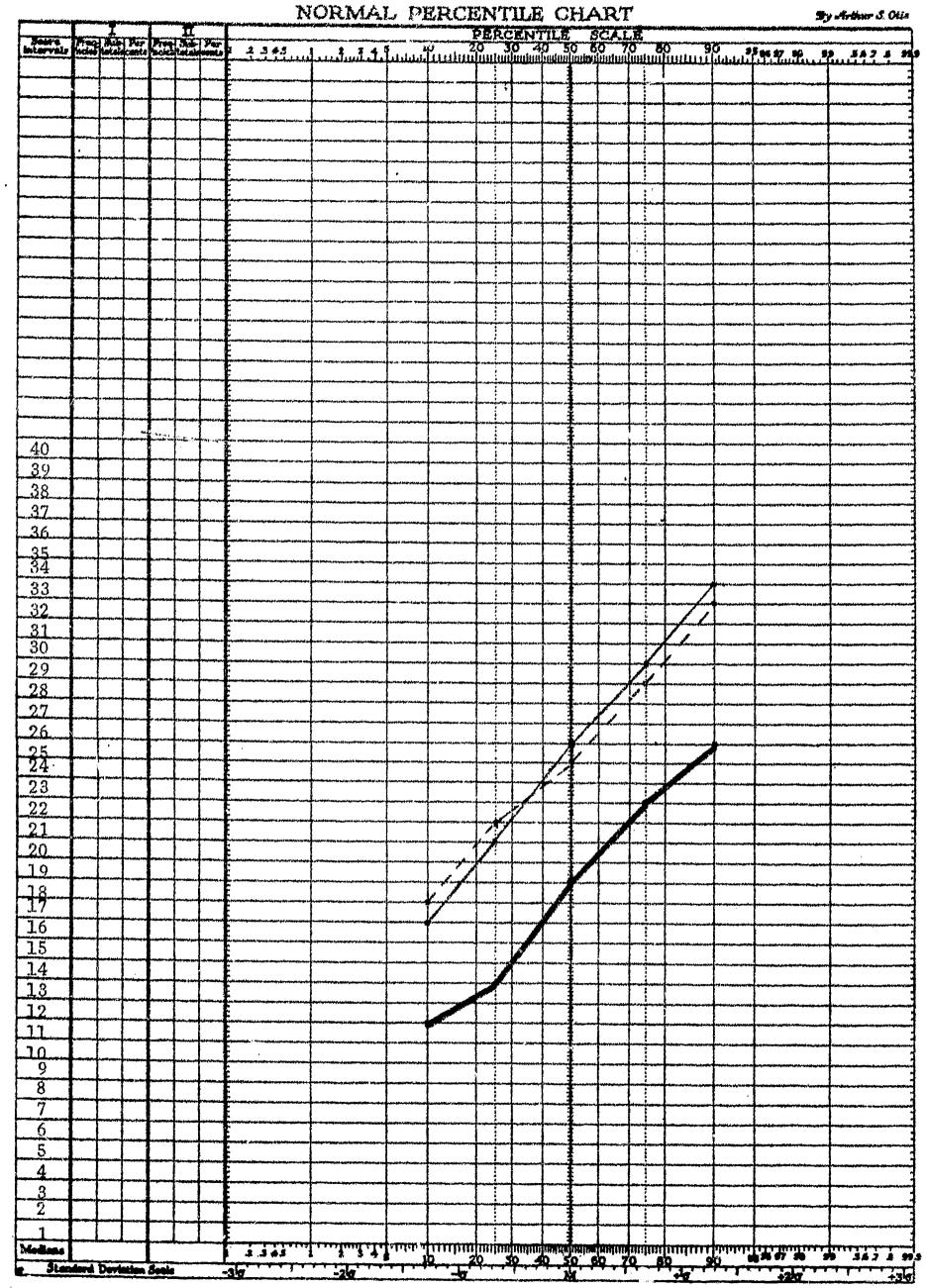
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Conclusions

Using the statewide grade 8 test data it became apparent in 1964 that there had been a significant drop in arithmetic computation scores since 1963. It was hypothesized that modern mathematics was contributing to this decline in computational ability. As a result of that hypothesis a study was conducted which we have already discussed at length. This study clearly indicated that students in the modern mathematics group were intellectually superior to those in the traditional or transitional group, while just the inverse was true in terms of their ability to do arithmetic computation. It should be noted here that one of the abvious weaknesses and problems associated with this study is, what is meant by the terms modern, traditional and transitional. These terms are not easily defined, but we have earlier presented Mr. Prevost's working definition of these terms.

The same study was replicated when the former eighth grade students were in the tenth grade. It is noted, again as one of the problems in the second study, that there were rather different degrees of student-loss between grade 8 and grade 10. There was a 9% loss for the modern group; a 32% loss for the traditional group and a 19% loss for the students in the transitional group. A number of hypotheses seem to explain this.

It is more likely that traditional students were classified or were found in small eighth grade systems which sent their students to high schools in another town for their high school education and that some of these high schools had to be eliminated from the study because the tenth graders in them were not all from schools that had been classified formerly as traditional, transitional or modern. The fact is possible for all three groups but more likely to have happened, in the author's opinion, with the traditional and transitional students. Since the students classified as modern tended to come from the more affluent communities, they tended to have their own high schools.

There is a second possible reason for the very significantly different student loss and that is that the traditional group again may be coming from smaller or rural communities whose students tend to stay in school a shorter period of time. This is somewhat less true for the transitional and the modern group.

A third possible reason is that the students who are classified as traditional found school, and its traditional orientation, not responsive to their particular needs and therefore were disappointed, and alienated from, the school at an earlier period since the school was doing little to sustain their interests in staying in school. This would account for the higher student loss. Whether or not this student loss affected the statistics reported for the tenth graders is not easily answered.

The results of the tenth grade study have already been reported in detail. It seems clear from those results that for the School and College Ability Test, the Verbal section is probably the truest indicator



of mental abilities and that there still is a significant difference between these three populations at grade 10 in terms of their intellectual prowess. This hypothesis is supported by the fact that there is a significant difference in English Vocabulary, Reading Total and English Expression in the same direction favoring the modern group. At the very least one could say that the students in the modern group are, in terms of their Verbal skills, significantly different from the students in the traditional and transitional groups. The order in all cases shows the modern group highest, transitional second and the trad-This is the pattern which has continued for the three itional, third. years of this study. In terms of arithmetic abilities, particularly arithmetic computation, it is no longer true at grade ten that there are significant differences between these three groups. This is verified twice, once in the Quantitative portion of the SCAT and secondly, as part of the Stanford Numerical Competence Test. In either case there is no significnat difference between the three groups. What this seems to clearly say is that while the students classified as modern have, at grade 8, less ability at arithmetic computation, apparently the two years of practice (grade 8, grade 9 and part of grade 10) cause them to increase their skills to the point where there are no longer any significant differences between the three groups.

It is particularly interesting to look at the Stanford High School Mathematics Test, Part A, results, in which we find a very significant F of 19.57, and to look at the means for the three groups, which are: modern group--26.09; transitional group--25.68; and traditional group--19.41. There are no significant differences between the modern and the transitional group but there are very significant differences between the transitional group and the traditional group and the modern group and the traditional group. I think it is worthy of note here that this difference not only seems to be statistically significant, but perhaps more important, educationally significant. It is beyond the scope of this present paper to make an analysis of what is causing that particular very significant difference but it is something that the author is presently engaged in researching. But it is easily hypothesized that the students in modern mathematics, when asked to work in the area of algebra and geometry, which is what this test measures, do markedly better than do their traditional counterparts. I think it is safe to say that algebra and geometry call for many more verbal skills than they do pure computational skills and it is here, apparently, that the greatest pay-off comes for the students who have studied modern mathematics.

One of the questions that needs to be raised relative to this piece of research is: how representative has the performance in mathematics of these eighth and tenth graders been to the entire eighth or tenth grade population in the state of New Hampshire? If one makes the comparison between Tables 7, 8 and 9, which present the raw scores obtained by the three 10th grade groups, at five selected percentiles, with Table 10, which is the same information for the entire state, one finds, particularly at the medians, that there are not many serious discrepancies between any two of the groups. The author believes it is safe to say that there is

at least as much variance within the three groups as there is variance between any one of the groups and the entire state. It therefore is the author's conclusion that these groups are in fact a representative sample of the entire state and not a special or unique sub-set of that population. These conclusions can only be reached for grade 10 because no such comparison was made on the eighth grade data in 1965.

Tables 7, 8 and 9 offer some additional interesting possibilities for study. It was noted in the body of the report that the students classified as the modern group seemed to do quite well in computation if they were found in the upper end of the spectrum in terms of the selected percentiles, i.e. the 75th or 90th percentile. Students classified as modern tended to do more poorly in computation if, in fact, they were found at the bottom of that scale, i.e. the 10th and 25th percentiles. The reverse seemed to be true for students classified in the traditional group. The students at the bottom of the scale, i.e. the 10th and 25th percentile, seemed to do better than one would have expected and the students at the upper percentiles, i.e. the 75th or 90th, seemed to do more poorly than one would have expected. There are some interesting exceptions to this in the paper so that it can not be presented as a flat set of statements. But it holds generally to be true. I think this finding argues very cogently for the concept of differentiated instruction, particularly at different ability levels.

APPENDIX



Footnotes

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A STUDY OF ABILITY AND ACHIEVEMENT IN MATHEMATICS OF THREE GROUPS OF TENTH GRADERS IN NEW HAMPSHIRE



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<u>List of Normal Percentile Charts</u>

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In the fall of 1967 the Bureau of Educational Research and Testing Services, acting as a contractual agent for the State Department of Education, conducted the annual 10th grade statewide testing program. This study concerns itself with the evaluation of the mathematical computational ability of a small subset within that much larger program. In 1967 there were 9,776 10th graders who participated in the statewide testing program. Of this number, 3,439 students were involved in a follow-up study comparing 8th grade computational ability with present 10th grade computational ability. Of the 3,439 students participating in the follow-up study, 620 students had elected to take the Stanford Mathematics Test, Part A, an optional test in the 10th grade battery which measures abilities in the area of algebra and geometry.

The 10th grade test battery consisted of the School and College Ability Test, Form 2B; the Cooperative English Test, Form 2C; the Stanford High School Numerical Competence Test, Form X; and the Stanford High School Mathematics Test, Form X, Part A and B. The Stanford Numerical Competence Test is recommended by the New Hampshire State Department of Education as a test which is appropriate to give all 10th graders in the state of New Hampshire. The Stanford Mathematics Test, Part A and Part B, is recommended by the State Department of Education as only suitable for those students who are involved in advanced mathematics courses in their school systems.

The original study in which these 620 students were involved was concerned with the question, does the type of text book that the teacher uses in the class make any difference in terms of the students' computational ability? The communities participating in that statewide program had been divided into three separate categories classified as modern, traditional and transitional, based on the type of textbook they were using. The working definitions of those classifications, as used in the original studies, are as follows:

Working Definitions for Classifying Schools Based on Texts

If the mathematics text used by the school showed no deviation from methods of presentation common in the late 1950's or early 1960's, and introduced a minimal amount of new math, it was judged to be traditional. Such texts were more frequently filled with long exercise sections; little structure or rationale in concept development was emphasized.

Texts which tended to approximate the California strand development were judged to be modern. Such texts placed stress on the development of concepts and concrete manipulations. Texts emphasizing mathematical systems, properties, functions and graphing, for example, met the criteria for modern.

Those texts which the publisher had admitted, or which Mr. Prevost judged, to have a middle of the road approach were considered transitional. These texts were somewhere



along the continuum of traditional to modern.

Where a school system did not fit into a category it was eliminated from the study.

In the original study of computational ability between 8th and 10th graders it was noted that there was a very large raw score difference in the means between those students that were classified as traditional, transitional or modern, on the Stanford High School Mathematics Test, Part A. The means being as follows: the modern group, 26.20; the traditional group, 19.68; and the transitional group as 25.93. This study is an attempt to see whether or not these differences were found only on the Stanford High School Mathematics Part A subtest or whether or not these difference were consistently found throughout the rest of the tests in this battery. In this present study the following numbers of students were in each group: in the modern group we had 226 students; in the traditional group we had 39 students; and in the transitional group we had 355 students.

The following analysis was conducted: a one-way analysis of variance, plus T tests, was done on 10 of the 11 tests in the 10th grade battery. The following are the results of those computations: on the School and College Ability Test the F's for the Verbal and the Total scores are both statistically significant and all the differences favor the modern group, secondly the transitional group and lastly, the traditional group. For the SCAT Quantitative the F is also statistically significant. There is only a statistically significant difference between the modern and the transitional group, favoring the transitional group. The means as well as the computed F's and T's are given in Table 1.

Following the analysis of the School and College Ability Test, a similar analysis was done on the Cooperative English Test. All of the computed F's are statistically significant at the 1% or 5% level, except English Expression on which there is a non-significant difference. All of the differences follow the pattern of results on the School and College Ability Test, Verbal and Total sections, with the modern group being the best, followed by the transitional group, followed by the traditional group. The means as well as the computed F's and T's are given in Table 2.

A similar analysis was conducted on the Stanford Numerical Competence Test and the Stanford Mathematics Test, Part A. On the Numerical Competence Test there is a significant F at the .01 level but the pattern has changed. Here the transitional group is performing markedly better than either the modern or the traditional group, a pattern similar to that noted on the School and College Ability Test, Quantitative section.

A similar analysis was conducted on the Stanford Mathematics Test, Part A. The computed F is significant at well beyond the .01 level. The study of the means of these three groups is worthy of our careful attention. The modern group and the transitional group do very well on this test, while the traditional group does very poorly. The means as well as the computed F's and T's are given in Table 3.



No computations or analysis were conducted on the Stanford Mathematics Part B test, because only students in the transitional and the modern groups took this test. No student in the traditional group elected to take Math B.

In the mathematical development of the analysis of variance, a number of assumptions are made. One assumption is that the distribution of variables and the population from which the samples are drawn are normal. Since this study is not based upon the drawing of a sample from a population, but is, in fact, a population itself, the use of analysis of variance can seriously be questioned. Because of the failure to meet this requirement, the project director, in consultation with other statisticians, decided that to pursue the project as originally proposed the analysis of co-variance for the 1967 study would be inappropriate, since the assumptions for simple analysis are not met. The assumptions are certainly not met for the analysis of co-variance; therefore, it was decided that the 1967 special sub-group data would be subjected to further analysis by computing selected percentile ranks as a basis for determining differential effects for above and below average students.

The test results of this special group were subjected to further analysis by computing selected percentile ranks as a basis for comparing the performance of above and below average students. Five selected percentile ranks were chosen for this study. They are: the 90th, 75th, 50th, 25th, and 10th. The comparisons provided indicate the raw scores at each of these selected percentile ranks for the students involved in the study. Table 4 presents this information for the School and College Ability Test; Table 5 for the Cooperative English Test; and Table 6 for the Stanford Numerical Competence Test and the Stanford Mathematics Test, Part A. The same information is presented graphically on Normal Percentile charts, I - X, which are found immediately following the selected percentiles. These Normal Percentile charts say, in graphical form, what the percentile tables say in tabular form.

Table 1

A COMPARISON OF SCHOOL AND COLLEGE ABILITY TEST

GRADE 10: Fall 1967

MATH A

	SCAT Verbal		SCAT Quantitative)	SCAT Total	
Modern Mean Group 1	37.00		31.72		68.72	
Traditional Mean Group 2	30.21		32.21		62.42	
Transitional Mean Group 3	36.20		33.84		70.04	
F's	6.743		6.464		4.386	
Significant	.01		.01		.05	
T's and Significance	e			•		
1 : 2 =	3.666	.01	0.400	NS	2.357	.05
1:3=	0.893	NS	3.530	.01	1.010	NS
2:3=	3.319	.01	1.360	NS	2.928	.01

Table 2

A COMPARISON OF COOPERATIVE ENGLISH TEST

GRADE 10: Fall 1967
MATH A

	Reading Vocab	Reading Level	Reading Speed	Reading Total	English Expression
Modern Mean Group 1	40.26	20.77	34.13	74.39	50.23
Traditional Mean Group 2	35.39	18.39	28.87	64.26	46.50
Transitional Mean Group 3	39.08	20.44	32.79	71.86	50.11
F's	5.897	4.436	5.422	6.527	2.116
Significant	.01	.05	.01	.01	NS
T's and Significand	ce				
1 : 2 =	3.361 .01	· 2.980	3.205 .01	3.527 .01	2.002 NS
1:3=	1.675 NS	0.852 NS	1.678 NS	1.804 NS	0.134 NS
2 : 3 =	2.614 .01	2.635 .01	2.453 .05	2.720 .01	1.989 NS

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Table 3

A COMPARISON OF STANFORD NUMERICAL COMPETENCE AND MATHEMATICS A TESTS

GRADE 10: Fall 1967

MATH A

	Numerical Competence	Mathematics A				
Modern Mean Group 1	29.45	26.20				
Traditional Mean Group 2	29.82	19.68				
Transitional Mean Group 3	31.71	25.93				
F's	7.527	20.731				
Significant	.01	.01				
T's and Significance						
1 : 2 =	0.301	NS 6.285 .01				
1 : 3 =	3.782	01 0.526 NS				
2 : 3 =	1.585	ns 6.191 .01				





Conclusions

Table 1, 2, and 3 present the analysis of variance for these three groups. It is clear from the results of that analysis that in those tests which measure verbal skills the modern and the transitional groups are very similar and that the traditional group is significantly different from them. no significant differences on any of the 7 tests between the modern and the transitional group on verbal measures. On the tests which measure mathematics and quantitative skills the situation is quite different. On the SCAT Quantitative and Numerical Competence tests, there are no significant differences between the traditional and the modern group and there is no: significant difference between the transitional and the traditional group. There is a significant difference between the modern and the transitional group, favoring the transitional group. When we come to Mathematics A, however, which is a test which measures knowledge of algebra and geometry, we find the pattern re-establishing itself that was true with the tests which measure verbal ability. There are no significant differences between the modern and the transitional group but there is a very significant difference between either the modern and the traditional group or the transitional and the traditional group, in both cases, favoring the modern or the transitional group.

The results of this analysis would seem to indicate the following is true about computation ability: if the textbook used in the school classroom is classified as either traditional or transitional, the students learn approximately the same amount that students in a traditional textbook learn but they do not learn as much as students in a transitional textbook do.

When, however, we look at the subject of algebra or geometry, it becomes very apparent that students studying with either the aid of a modern text or a transitional text apparently perform markedly better than students who study only with a traditional text.

Tables 4 - 6 and percentile charts I - X give us some additional information about these three groups. These tables and charts confirm what we have already said as the result of the analysis of variance, namely that we are dealing with two separate populations here as measured by the testing of verbal skills. The modern and transitional group seem to make up one group and the traditional group seems to be a rather separate entity. The tables and charts seem to clearly indicate that the modern and transitional group perform markedly superior to the traditional group at all levels on tests which measure verbal skills.

The separateness of these populations changes when we talk about quantitative skills or computational skills. Here the transitional group stands by itself while the modern and the traditional group stand together. On the Computation subtest the charts and tables clearly indicate that at all levels the transitional group is performing markedly superior to the modern and traditional group.



On the Stanford High School Mathematics Test, Part A, the table and graph clearly indicate that the traditional group, at all selected percentiles, is performing markedly poorer than the other groups, transitional and modern. The raw score differences found at these selected percentiles in this table and chart can not, in the author's opinion, be attributed solely to the community or genetic factors or environmental factors with which these children come to school. It seems clear to him that the great difference is also markedly the result of the instruction, i.e. the textbook, and that the students who were taught using either a transitional or modern textbook had a marked advantage when it came to the subject of algebra and geometry, over those students who had studied from a traditional text.



Table 4

A COMPARISON OF SELECTED PERCENTILES FOR SCHOOL AND COLLEGE ABILITY TEST

<u>GRADE</u> <u>10</u>: <u>Fall</u> <u>1967</u> MATH A

NAME OF TEST	SELI	ECTED PERC	CENTILES I	N RAW SCO	RES
	<u>10th</u>	<u>25th</u>	<u>50th</u>	75th	<u>90th</u>
SCAT Verbal					
Modern Group Traditional Group Transitional Group	21 19 22	29 23 28	37 28 36	45 38 44	50 44 50
SCAT Quantitative					
Modern Group Traditional Group Transitional Group	22 25 24	27 28 29	32 32 34	36 36 38	40 40 42
SCAT Total					
Modern Group Traditional Group Transitional Group	45 44 49	59 54 59	69 62 70	79 71 80	87 81 89

Table 5

A COMPARISON OF SELECTED PERCENTILES FOR COOPERATIVE ENGLISH TEST

GRADE 10: Fall 1967

MATH A

IAME OF TEST	SELI	ECTED PERC	CENTILES 1	N RAW SCO	ORES	
	<u> 10th</u>	<u>25th</u>	<u>50th</u>	<u>75th</u>	<u>90tl</u>	
Reading Vocabulary						
Modern Group	29	34	40	45	51	
Traditional Group	25	30	35	39	44	
Transitional Group	27	33	39	45	50	
Reading Level						
Modern Group	14	17	21	24	26	
Traditional Group	12	15	18	21	24	
Transitional Group	14	17	20	23	25	
Reading Speed	, , , , , , , , , , , , , , , , , , , ,					
Modern Group	20	28	34	40	46	
Traditional Group	18	22	28	33	40	
Transitional Group	20	25	33	39	45	
Reading Total						
Modern Group	51	64	75	85	95	
Traditional Group	45	54	64	71	82	
Transitional Group	49	59	72	84	94	
English Expression						
Modern Group	36	42	50	57	64	
Traditional Group	35	41	45	53	57	
Transitional Group	37	43	49	57	64	

A COMPARISON OF SELECTED PERCENTILES
FOR STANFORD NUMERICAL COMPETENCE AND MATHEMATICS A TESTS

Table 6

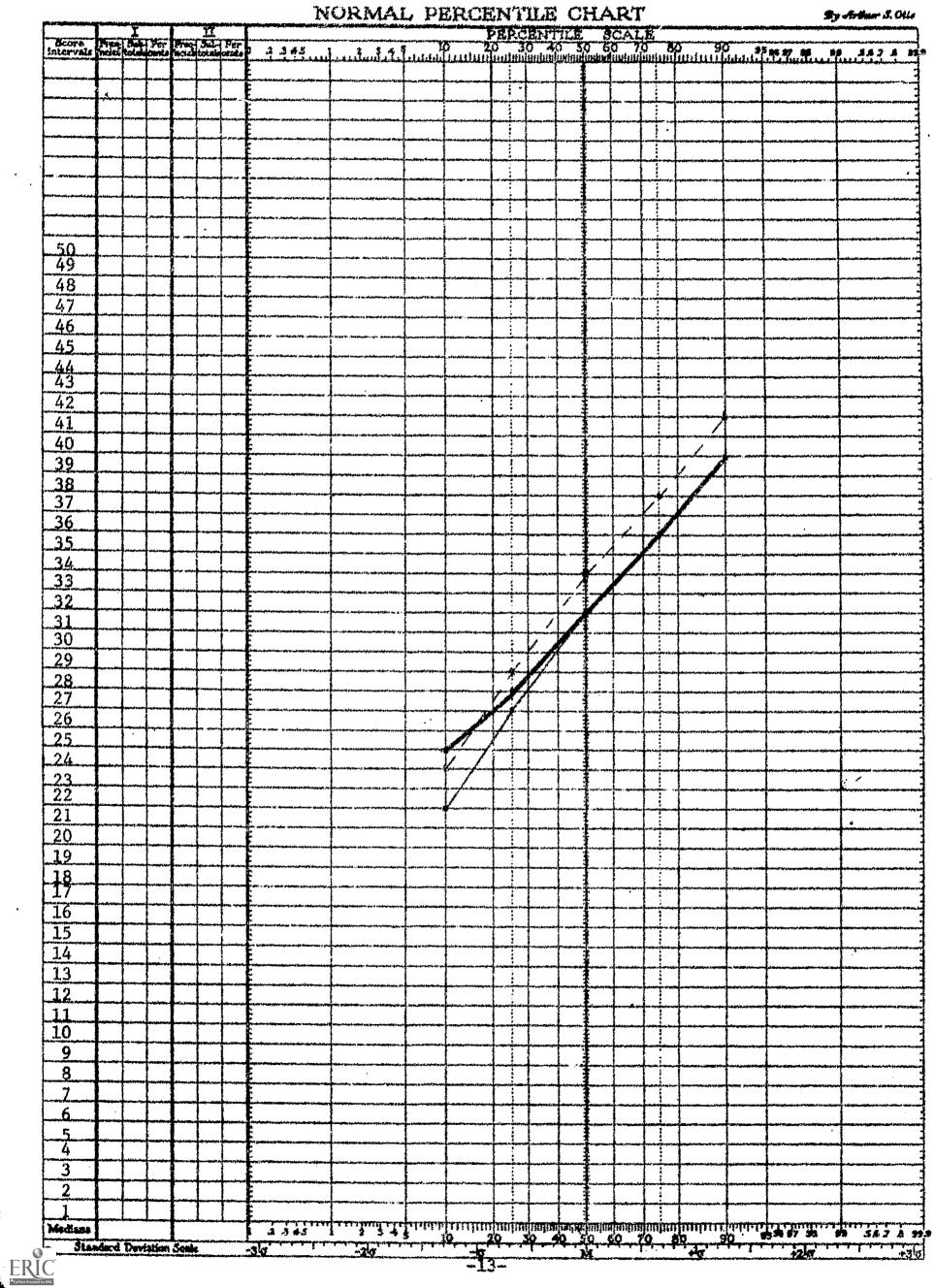
GRADE 10: Fall 1967 MATH A

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By Arthur S. Otto

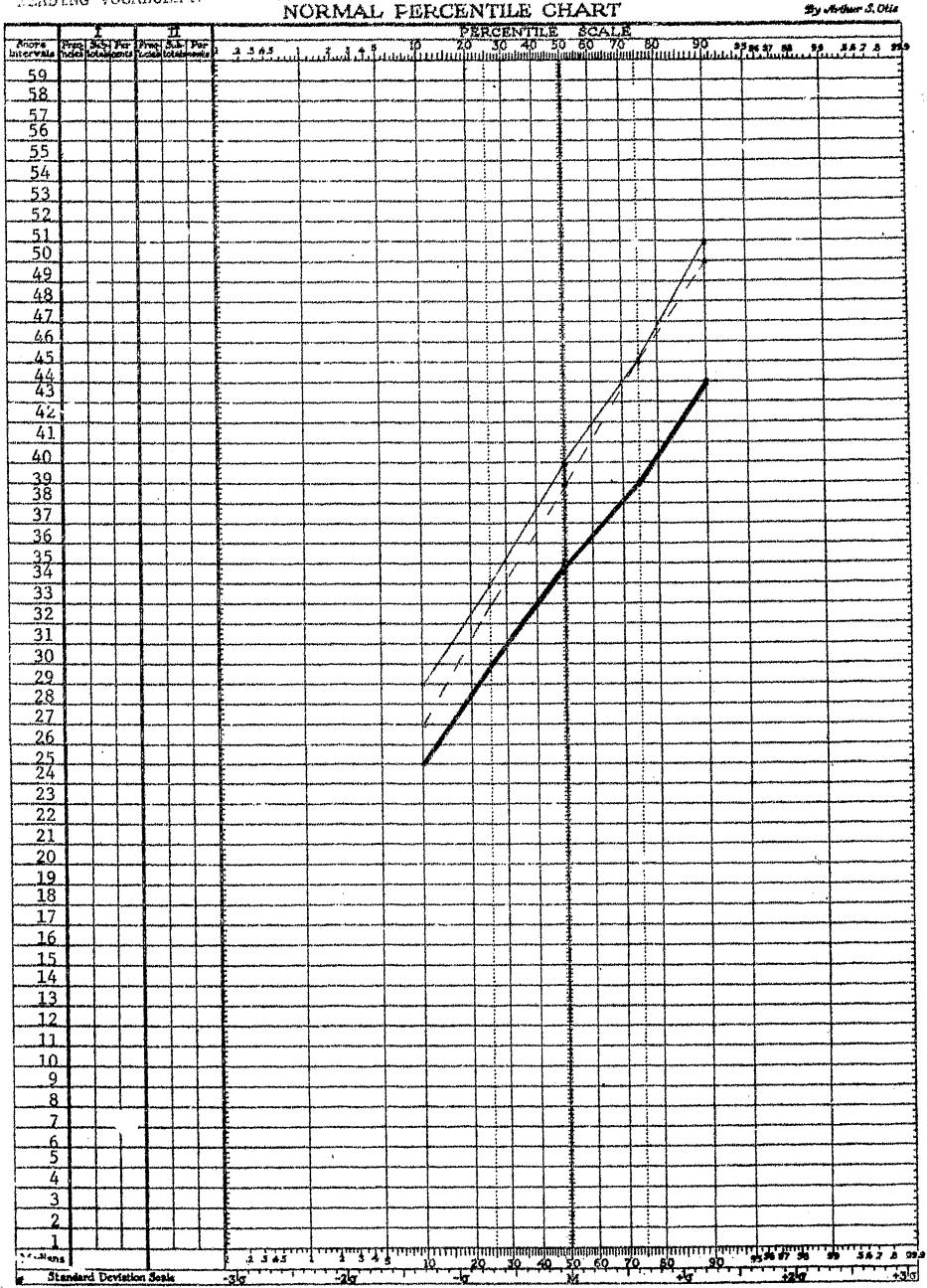


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Standard Deviation Scale

By Arthur S. Olie



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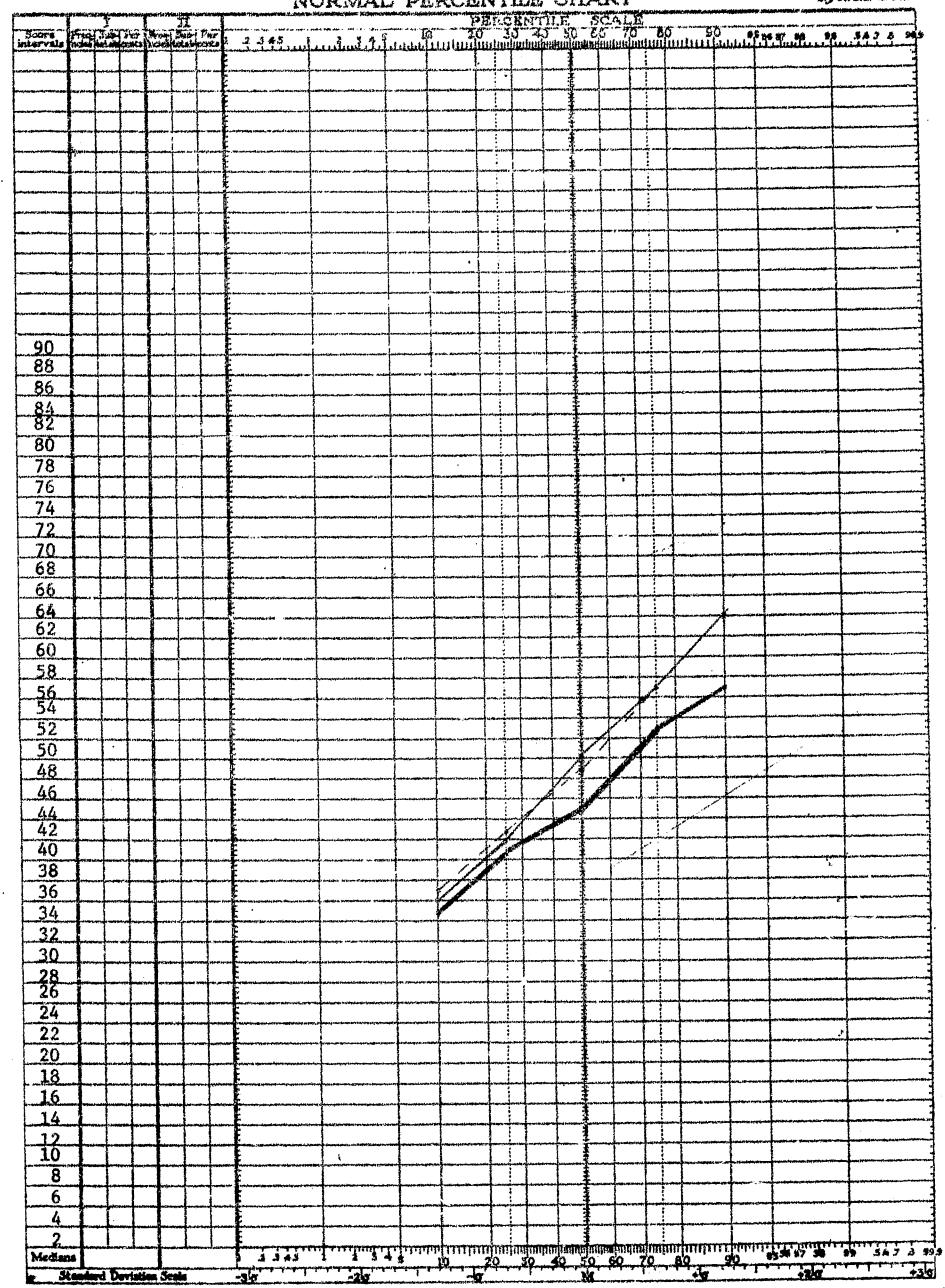
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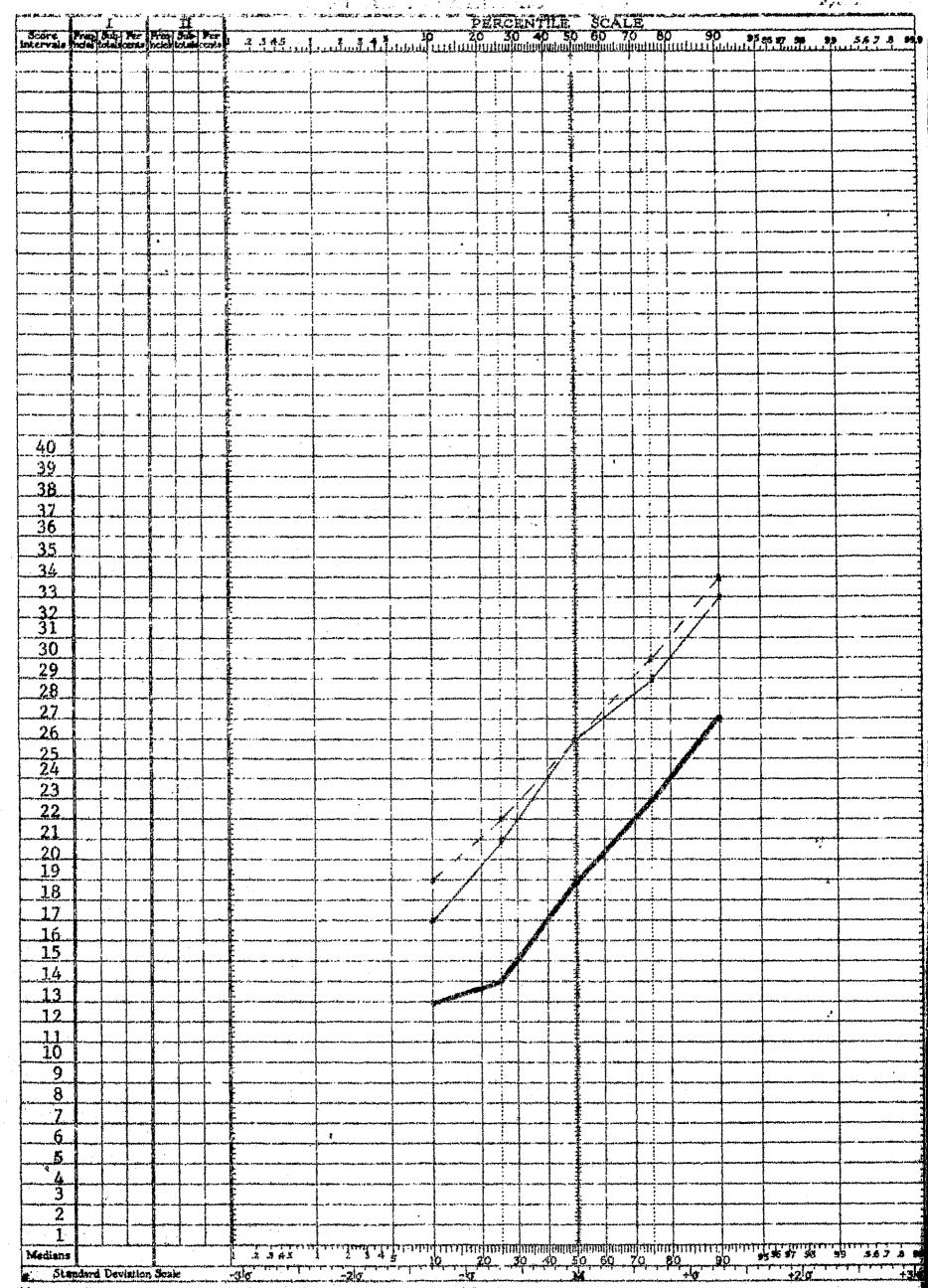
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-21APPENDIX



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